UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

2012-5067

JOHN H. BANKS et al.,

Plaintiffs-Appellants,

v.

UNITED STATES,

Defendant-Appellee.

Appeal from the United States Court of Federal Claims in consolidated case numbers 99-CV-4451, 99-CV-4452, 99-CV-4453, 99-CV-4454, 99-CV-4455, 99-CV-4456, 99-CV-4457, 99-CV-4458, 99-CV-4459, 99-CV-44510, 99-CV-44511, 99-CV-44512, 99-CV-365, 99-CV-379, 99-CV-380, 99-CV-381, 99-CV-382, 00-CV-383, 00-CV-384, 00-CV-385, 00-CV-386, 00-CV-387, 00-CV-388, 00-CV-389, 00-CV-390, 00-C-391, 00-CV-392, 00-CV-393, 00-CV-394, 00-CV-395, 00-CV-396, 00-CV-398, 00-CV-399, 00-CV-400, 00-CV-401, 05-CV-1353, 05-CV-1381, and 06-CV-072, Chief Judge Emily C Hewitt.

JOINT APPENDIX VOLUME IV

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UNITED STATES COURT OF APPEALS FOR THE FEDERAL CIRCUIT

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REBUTTAL EXPERT REPORT OF MICHAEL 1 MOORE

I. INTRODUCTION

1. I, Michael J. Moore, al:tithe sole member of Charlottesville Partners, LLC, located in Charlottesville, VA.' I received my Ph.D. in Economics in 1984 from the University of Michigan. My professional career has been devoted to research, teaching, and consulting in applied microeconomics, including the fields of industrial organization, health economics, econometrics, labor, and law and economics. I serve or have served on the faculties of the University of Chicago (Graduate School of Business), University of Virginia (Batten, Darden, Economics, Medical School, and Law), Duke University (Fuqua School of Business, Terry Sanford Institute of Public Policy, and the Center for Aging, Duke Medical Center), INSEAD, UC-Santa Barbara (Donald Bren School of the Environment), and the University of Georgia (Terry College of Business). In 1998-99, I was the John M. Olin Fellow in Law and Economics at the George Stigler Center at the University of Chicago. I have published approximately 50 articles in scholarly journals, monographs, and proceedings, and have acted as referee for hundreds of articles submitted to the leading scholarly journals in economics, law and economics, management, and health policy. My research has been funded by the National Science Foundation, the National Institutes for Health, and the U.S. Veteran's Administration.
2. My published research consists almost entirely of economic analyses of real world problems. I have won three awards for this research: the Kenneth Arrow Award for Best Paper in Health Economics (1993), the Kulp-Wright Award for Best Book in Risk and

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I am also employed by Navigant Economics, 30 S. Wacker Drive, Chicago IL 60606. My report in the matter is not associated with Navigant Economics in any way.

PLAINTIFF'S EXHIBIT 149

Insurance (1992), and the Best Article Award (1988) from the economics journal *Economic Inquiry*.

3. My expertise in this matter lies in my general knowledge of economies and of the econometric and statistical methods often used to compute economic damages. I am being compensated for my work at the rate of $710 per hour.

4. My curriculum vitae and record of testimony are presented in Exhibit 1. Exhibit 2 lists the specific documents that I have reviewed in forming my opinions.

5. I reserve the right to augment or alter any of the opinions expressed herein upon receipt of further evidence or information.

H. PRINCIPAL CONCLUSIONS

6. Defendant's expert Mr. David Burgoyne of Burgoyne Appraisal has offered an analysis that measures damages due to the erosion in two distinct scenarios using appraisal methods. His analysis uses selected comparable properties to compute unit prices of unimproved lots (price per lakefront foot) and improved lots (price per square foot)? These unit prices are then adjusted to each specific Plaintiff's property using the dimensions and features of the property as they existed in 2000, 1950 and at the time of acquisition. In almost all cases, Mr. Burgoyne's method returns damages estimates that are equal to zero. Since the two dimensions that he uses to compute values at each evaluation point (lakefront footage and gross square feet of living space) do not vary across the evaluation points, there can be no differences in values across these points due to changes in these two dimensions of the property.

[2] The same set of 14 properties is used for all of the appraisals "as vacant." For the appraisals "as improved" a subset of a clataset of improved comparables in chosen,

7. In four instances, Mr. Burgoyne does allow the adjustments to the Plaintiffs' unit prices to vary over time. This is always due to a complete failure of some feature of the property — the disappearance of the beach (Chapman, Jackson, and Reimers) and the collapse of the bluff under a house which made the lot unbuildable (Neuser). In one other instance (Notre Dame Path Association), "cost to cure damages" are allowed,[3] Absent these 5 failures, zero damages are the almost inevitable result of Mr. Burgoyne's analysis. In the absence of a complete failure in certain features of the property (such as the collapse of a bluff or loss of beach), his analysis will return an estimate of zero damages by construction.

8. There is a subtle problem underlying the "lumpy" or "discontinuous" nature of Mr. Burgoyne's analysis. There are relevant features of the affected properties here that are difficult for analysts to measure the risk of failure and the risk that damages cannot be permanently abated, for example. When information about these risks is made public, they will nonetheless be assessed by market participants and incorporated in prices.[4] Such unobserved risks will vary continuously, so that changes in these risks (and in any other unobservables that are correlated with the erosion and with prices) need to be controlled for in analyzing the economic impact of the erosion. Since these unobservables vary continuously, and since the proxies for changes in the characteristics of the property used by Mr. Burgoyne to assess changes in value do not, his measures are not capable of captiring all of the variation in the unobservables_ The only way to do this that I am aware of, as an economist, is to measure prices before and after the

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[3] In the absence of the failure of the shore protection in this case, Mr. Burgoyne would have returned a damages estimate of zero.
[4] The risks could be mitigated by insurance or warranties in some instances.

qualifications. Finally, prices of unaffected and not necessarily comparable properties could be compared to those of Plaintiffs' properties before and after the information became public and the "difference-in-differences" of prices would provide an estimate of damages. Again, this estimate is useful subject to some qualifications.

21. I will refer to these three "tests" as the "cross-sectional," "before-after," and "difference-in-differences" tests. For the cross-sectional test to work, the comparison properties must be otherwise comparable (or somehow made comparable) to the affected properties. Otherwise, differences in the two groups that are not controlled for will confound the damages estimate. In the before-after test, it must be the case that there are not other changes over time that would affect the value of the affected properties. Otherwise, the effects of these changes would be incorrectly attributed to the erosion. Finally, in the difference-in-differences test, average differences between the affected and unaffected properties at baseline must remain constant over time, so that changes in the relative values of the two groups of properties can be attributed to the erosion.

22. Once a damages estimate has been computed, the timing of the event, or of information releases regarding the event, must be determined. Anyone who purchased after, or sold before, the relevant event or information release became reflected in prices would riot be harmed. Again, the stock price analogy is relevant here.[15]

23. In this litigation, information about the beach erosion was present long before January 2000 regardless of whether the causes were clearly understood - and the effects of this knowledge would be reflected in the prices of affected properties at the time the facts

[15] Stock prices are an extreme example, however, in the sense that securities markets are highly "information efficient." For a recent exposition, see MacKinlay, A. Craig (1997), "Event Studies in Economics and Finance," *Aland of Economic Literature* 35(1): 13-39.

became known. To take one example of such "leakage," consider the inscription on the plaque at the park at 3220 Lakeshore Drive describing the events in October of 1954, when heavy rains caused the bluffs on Lakeshore Drive to collapse along with six houses, and with five other houses moved to different locations.[16] Two facts are notable about the plaque memorializing the event. First, in the opening paragraph:

> "In the early 1950s, at the point at which you now stand, nature was taking its toll along the shores of Lake Michigan. Erosion; caused by natural conditions, such as wind and rain, as well as unnatural conditions, such as the disruption of currents caused by the dual piers just north of this site, was gradually occurring."

Second, at the end of the narrative:

> "Erected in 1995"

24. Thus, information about erosion and the attendant risks was available in 1995 and presumably before that date, since the houses described.on the plaque slipped into the lake fully 46 years before the January 2000 evaluation date.

25. In my opinion, it is not possible in this litigation to estimate the full impact of the beach erosion on real estate values. It is apparent that information about the problem was emerging at an early stage, and there is no record available to identify the timing or the content of events and information releases from 1950 to 2000.

26. It is possible, however, to estimate the effects of the January 2000 public information release. If there was any residual uncertainty about whether the damage was permanent prior to this announcement and the announcement eliminated this uncertainty, then relative real estate values would adjust. Any measured changes in these relative values

[16] This inscription also brings into question assumptions made by 'Burgoyne Appraisal regarding the cost of future containment, in that Burgoyne assumes a smooth rate of erosion (15 feet/year) (see, e.g., Anderson appraisal, p.160), when it is clear from this episode that heavy rains can lead to erosion that is anything but smooth. In the Lakeshore slid; the first major earthslide included "a chunk of land 25 feet wide and I50 feet long down the bluff...A second earthslide occurred ...the following morning, October 17. This earthslide measured 25 feet wide by 60 feet long..."

following the announcement could then be interpreted as reflecting the real estate market's assessment of the increase in the likelihood of permanent damages.[17] Logically, this estimate would provide a lower bound on the total value of damages.

27. As a simple example, suppose a property is worth $500,000 in the absence of any erosion risk. In the alternative, if there is a 90% chance of a total loss due to erosion, the expected impact of the erosion on the property would be $450,000.[18] If it is publicly known that the risk of a total loss is 90%, no one would pay more than $50,000 for the property.[19] If the probability of a total loss then goes up to 100%, no one would pay anything. The total loss would equal $500,000 and the amount attributable to the upward revision in the risk estimate would equal $50,000. Someone who purchased before the 90% risk became known (assuming 0% risk at time of purchase) would have lost $500,000 after the revision, and anyone who paid $50,000 for the property with knowledge of the 90% risk but before the fmal risk assessment became public knowledge would lose $50,000.

28. It is important to note that, just as in the securities fraud example outlined above, the results of the analysis of the January 2000 announcement will provide an estimate of the effects of eliminating residual uncertainty. Since some information had already leaked into, the market, some portion of damages should already be reflected in real estate transaction prices.

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[17] Again, this inference would be conditional on there being no other concurrent event affecting values in one group of properties or the other.
[18] For simplicity I assume that the loss increases linearly with the risk.
[19] Again for simplicity I assume in this example that there arc no other factors, idiosyncratic or otherwise, that might lead some buyers to pay different amounts.

29. The second piece of the analysis determines who owned the property before and after the admission. Someone who sold prior to the announcement, or who bought after it, would not be affected. Prior sellers might have been damaged too, or might not — the extent of damages depends upon the timing of events and information flows relative to ownership.

30. The analysis here would proceed as follows. First, attempt to determine the market value of the Plaintiffs' properties at the evaluation point ("event date") of January 2000. Second, identify "comparables" in an. otherwise identical, but unaffected area, and determine their market values at the same point in time. The difference in the market values between affected properties and benchmarks estimates the economic effect of the beach erosion. If no unaffected comparables can be found, the alternative second step is to find "non-comparables" in an unaffected area, and make them as comparable as possible using appraisal methods or econometric techniques. If the adjustments in the alternative second step are not adequate (i.e., if the "treatment" and "controls" cannot be made comparable), another alternative approach is to first collect data on market values for both the affected and unaffected properties before the event occurred and record the difference. Second, record the difference in market values between affected and unaffected properties after the event. Finally, compare the differences in values after to the differences before. Any excess would be the estimate of loss due to the event. This "difference-in-differences" method is the method that I utilize below.

V. THE BURGOYNE APPRAISALS

31. In my opinion, the appraisals offered by Mr. Burgoyne in this litigation have significant limitations. One valid approach, which I implement here, measures changes in unit

values of affected properties due to erosion "events" or to information releases about the nature and extent of any erosion event, and multiplies these changes by the relevant units to compute damages. An alternative (possibly) valid approach would compute a unit value based on a unit that could be affected by the event, and multiply this unit value by the differences in units before and after the event.[20]

32. The former method is in a weak sense closer to what Mr. Burgoyne does, but it is not what he does for a fundamentally important reason. Mr. Burgoyne computes an average unit value for a set of selected comparables, and then adjusts these unit values based on measured characteristics of each plaintiff's specific property at these points in time to arrive at appraised unit values for each plaintiff. Denominator units are either lakefront footage (LFF) for "appraisal as vacant" or gross living area in square feet (GLA) for "appraisal as improved." Mr. Burgoyne then multiplieS the unit values by levels of units at various evaluation points to arrive at his estimate of damages. The three acquisition points chosen are 1950, acquisition date, and 2000.

33. There are two problems with Mr. Burgoyne's method. First, rather than base his appraised values on a measure that could in theory be affected by any erosion events he uses units that are constant over time. That is, he uses the same number of units for LFF and GLA in 1950, 2000, and at time of acquisition. Second, he almost always uses a single price per unit for all three evaluation points. This reflects the fact that his analysis only returns changes in unit values of Plaintiffs' property when there are discrete "failures" in observable features of the property, such as the loss of a beach of the

[20] This method would work in theory if the units are causally linked to erosion, and if there are no other property dimensions that are also affected by the erosion (e.g., depth of beach or steepness of beach access). If the latter condition does not hold, there is no way to vary one characteristic while holding the others constant, so that a unique damage estimate cannot be identified.

complete collapse of a bluff. As a result, the values that he arrives at for each evaluation point are almost always identical, and Mr. Burgoyne's method almost always returns a damages estimate of zero.

34. An algebraic example can perhaps help illustrate this problem, By definition, the value of any property, *V*, can always be partitioned into the product of "value per unit" (v)and the "number of units" *(U),* so that total value is given by the expression $V =$ vU, Changes in value can arise due to changes in either or both components. That is, *aV* = vAU + Uttv + AvAU.[21] Changes in value (AV) then must be due to either changes in value per unit *(LI 1\v)* or changes in the number of units (vAU). Since Mr. Burgoyne almost always sets both of these changes to equal zero (Ay = = 0) (neither units nor value per unit change between evaluation points), he almost always finds zero damages.

35. Plaintiff Anderson's property is appraised by Mr. Burgoyne "as vacant" at $4,000/LFF, using data from fourteen property transactions identified as undeveloped from the affected area.[22] Similarly, using six transactions deemed "most comparable," Mr. Burgoyne also estimates a unit value of improved property of $200/GLA. These unit values do not change over time. To compute damages, Mr. Burgoyne then essentially multiplies these unit values by differences in LFF between evaluation points (for vacant property) and by differences in GLA (for improved property) for the same evaluation years. These differences are always zero.

[21] The last component (the "second order" component) can be ignored for purposes of this argument, as it is much smaller than either of the "first order" components.
[22] Some of the lots that WIT. Burgoyne describes as "vacant" in fact show square footage in the MLS Listings provided by defendants.

36. In a small number of cases, Plaintiffs' property values as appraised by Mr. Burgoyne vary due to discrete changes in the features of the property. In four instances, the unit prices are allowed to vary over time. This is always due to "failures" in features of the property — the disappearance of the beach (Chapman, Jackson, and Renners) and the collapse of the bluff under a house which made the lot unbuildable (Neuser). In one other instance (Notre Dame Path Association), "cost to cure damages" are allowed, again due to a failure. Absent these 5 instances, zero damages are the almost inevitable result of Mr. Burgoyne's analysis. In the absence of a discrete change in certain features of the property, his analysis will return an estimate of zero damages by construction.

37. There is a subtle econometric problem underlying the "lumpy" or "discontinuous" nature of Mr. Burgoyne's analysis. There are relevant features of the affected properties here that are difficult to measure — the risk of failure and the risk that damages cannot be permanently abated. These risks will be assessed by market participants and incorporated in prices. Such risks will vary continuously, so that changes in these risks (and in any other unobservables that are correlated with the erosion and with prices) need to be controlled for in analyzing the economic impact of the erosion. Since these unobservables vary continuously, and since the proxies for changes in value used by Mr. Burgoyne do not, his measures are not capable of capturing all of the variation in the unobservables.. In the example introduced above, changes in unit value are due to observed factors *(x)* and unobserved factors *(E)*, i.e., Av $Av(x, E)$. By allowing values to change only due to complete failures in observable characteristics, Mr. Burgoyne implicitly imposes the assumptions $(\overset{4v}{\ }) = 0$ and $(\frac{aE}{ax} = 0)$. In other words, his method is not capable of capturing the effects of unobserved or unmeasured factors that are

correlated with both the erosion and with the value of the property. The only way to do this that I am aware of as an economist is to measure prices before and after the discontinuous events, control for other unobservables over time using a control group, and measure the difference in prices. Price changes will reflect market participants' views of the all known factors that affect price, whether observable to or immeasurable by the analyst, and whether continuous or discrete.

VI. DIFFERENCE-IN-DIFFERENCES ANALYSIS OF THE 2000 DISCLOSURES

38. My analysis identified properties outside the affected area that had been sold hi the years 1937-2003, using data provided by defendants.[23] **I** entered data on selling price, location, date of sale, and square footage_ **I** created the dependent variable "price per lakefront foot," by dividing selling price by reported lake frontage (LFF). I also created indicator variables for location and for whether the sale occurred before or after the event date of January 27, 2000. The location indicator variable "treatment" equals one if the sale is in the affected area, and equals 0 otherwise.[24] The variable "post" equals 1 if the sale occurred on or after January 27, 2000, and 0 if before. Finally, the "interaction term" "treatpost" equals the product of "treatment" and "post" I considered single family homes with lakefront only. Sale prices less than $200 were dropped from the analysis 25

39. There are two ways to conduct the analysis.[26] First, a simple comparison of mean differences in selling prices pre- and post-announcement gives an unconditional estimate

n Data sources and the process of compiling and coding the data are discussed in Exhibit 5.

[24] Communities in the affected area include portions of St. Joseph and Stevensville. Communities in the unaffected area include portions of St. Joseph and Stevensville, as well as Benton Harbor, Coloma, Bridgman, Chikaming, Lakeside, New Buffalo, Sawyer, and Union Fier.

[25] 1n addition to a description of the data sources and coding, Exhibit 5 also contains a printout of the final data I relied upon.

[26] For a summary, see Wooldridge, Jeffrey M. (2008) *Introductory Econometrics: A Modern Approach,* 4th Edition. Southwestern, ch. 13, 14.

of the change in relative values after the announcement. Second, it is possible to adjust for characteristics of the houses in the four "groups" (pre-2000/treatment, post-2000/treatment, pre-2000/control, post-2000/control) using multiple regression with control variables added for features of the housing. Because of data limitations, I use only two single control variables here - a measure of square footage of the structure and dummy indicators of LFF between 100 and 150 feet, and LFF greater than 150 feet - to control for differences in price due to differences in the size of the house, and for potential nonlinearities in the effects of LFF on price.[27] To the extent square footage is correlated with other characteristics (number of rooms, number of bathrooms), controlling for square footage will capture price variation due to these features too.

40. Exhibit 3 summarizes the results of my analysis of unconditional mean prices for improved lots. Averages are shown for the four relevant conditions — treatment—'NO", pre--."NO" for unaffected properties post-announcement, etc. As Exhibit 3 illustrates, unaffected houses sold for an average price of $5205/LFF before the announcement in the unaffected area, and for $2589/LFF in the affected area. This establishes a baseline (pre-announcement) difference of $2616/LFF higher prices in the unaffected area. In the post-announcement period, homes in the unaffected area sold for $11194/LFF on average, while those in the affected area sold for an average price of $62811LFF. The post-announcement difference thus equals S4913/LFF. The difference in the relative values comparing post- to pre-announcement prices of $2297/LFF is the unconditional estimate of the average difference-in-differences estimate of damages.

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[27] See the discussion in the Burgoyne Appraisals indicating nonlinearities in returns to lakefront footage occurring at about 100 feet of lakefront.

41. A careful inspection of these results might lead one to conclude that there is no meaningful difference in the changes in property values, since they are roughly identical in terms of rate of return (% increase in price). Since the results are unconditional, it is necessary to determine whether the observed differences (in absolute and percentage terms) persist once controls are made for differences in the portfolios of properties considered.

42. To control for such differences in the properties used in forming the four groups, I also estimated a regression model for improved lots with price per lakefront foot as the dependent variable,[28] and with square footage and the indicators for whether the sale was in the affected area (treatment), whether it occurred after the announcement (post), and the interaction of these two indicators (treatpost). To attempt to control for nonlinearities in prices of lakefront footage, I also estimated this model with two LFF dummies, one indicating LFF from over 100 up to 150' (inclusive) and the other LFF greater than 150'. The estimated coefficient on the treatpost variable provides an estimate of the average difference in housing prices per LFF in the affected area relative to those in the unaffected area, controlling for differences that existed before the announcement, for nonlinearities in the effects of LFF on price (in the second model), and also for differences in the size of the house. The estimate in the first model is $2,676 lower in the erosion zone. When I add the LFF dummies, the estimated average difference-in-

[28] j also estimated all of the models using price per square foot of GLA as the dependent variable. The results were the same.

differences is $3,395 per LFF. Both estimates are larger than in the unconditional estimates.[29]

43. To address my concern about rates of return, I also estimated the model using the natural logarithm of PPLF as the dependent variable. In this setup, the coefficient on the "trtpost" variable returns the percent difference in differences. The point estimate in model 1 (without the LFF dummies) is -13% for the affected area. With the LFF dummies added, the estimated "discount" equals about -27%.

44. Neither the 13% nor the 27% estimates are significantly different from zero. Given the small numbers of observations in the relevant cells, this is not surprising. Perhaps more importantly, with small numbers of observations it is possible that individual observations might have a considerable influence on the estimated coefficients and their standard errors. These "outliers" are often a problem in applied research in my opinion best practice is to examine influential observations carefully and attempt make an informed judgment about whether they are valid, or whether they appear to be recorded in error 3[0] Results should be reported with and without the outliers, which I do in Exhibits 4A.3 and 4B.3.

45. It is clear from Exhibit 4 that the outliers are influencing the results. In Exhibit 4B .3, for example, the estimated coefficient on the "treatpost" variables indicates prices are about 42% lower in the erosion zone after the disclosure, and the estimated coefficient is now greater than its standard error, albeit still statistically insignificant.

29 Note the estimates in Exhibit 4.A.lon the variable "post' of $5872, and on "treatment' of -$2277. These indicate that prices across both locations were over $5900 higher post-announcement (likely due to the start of the housing boom) and that they were about $2300 lower in the affected area than in the unaffected area before the announcement.
" Five "outlying" observations are evaluated —two with sales price greater than $3 million, and 3 with sales price per LFF less than $1000.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge, information and belief.

Executed on June 25, 2010

Michael J. Moore

EXHIBIT 1

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ACADEMIC EMPLOYMENT & AFFILIATIONS

University of Virginia: Batten Fellow, Batten Institute, Darden Graduate School of Business, 2009-present; Visiting Professor, Frank Batten School of Public Policy, 2008-present; Department of Economics, 2006-2008; Darden, 2005-present; Bank of America Research Professor, 2003-2005, Professor, 2001-2002, Visiting Associate Professor, 2000-2001, Darden Graduate School of Business; Professor of Health Evaluation Services, UVA Medical Center, 2001-2003; UVA Law School 2005.

National Bureau of Economic Research; Research Associate, Health Economics Program, Health Policy Program, 1996-2008.

University of Chicago: Graduate School of Business, Adjunct Professor of Economics, 2007; Stigler Center for the Study of Economy and the State, Olin Fellow, 1999-2000.

University of Georgia: Terry College of Business, Visiting Professor, 2007- present.

UC-Santa. Barbara, Brett School of the Environment: Visiting Professor, 1999-2006.

EXHIBIT 1

Duke University: Associate Professor (with tenure), 1992-2001, Associate Professor (without tenure), 1990-1992, Assistant Professor, 1986-1989, Visiting Assistant Professor, 1984-1985, Terry Sanford Institute of Public Policy, various years, Center for Aging, 1994-2001.

INSEAD: Visiting Professor, 1995-96

University of Michigan, Graduate School of Business: Instructor of Economics, 1981-1984

EXHIBIT 1

EDUCATION

University of Mc' sigan, Department of Economics, 1984, M.A., 1982

M.B.A. Babson Colley: 1978

B.S. Boston Cc' iege, 1975

AWARDS AND HON' „MS

Kenneth Arrow Ave-, d for best paper in Health Economics, Medical Care Section, American Public Health Ass(` sciation, for "Drinking and Schooling" (1993)
Kulp-Wright ri, for Outstanding Book in Risk and Insurance, American Society of Risk and Insurance, *Con– pensation Mechanisms for Job Risks*
Best P-ublishe-' I Article published in *Economic Inquiry,* "The Quantity Adjusted Value of Life", 1988

RESEAr NCH GRANTS AND OTHER CONTRACTS

Cente • r for the Study of Aging and Human Development, Duke University Medical Center, Senior Fell .)w 1994-2001
1/¯ siversity Research Council, Duke University, 1986, 1987
4ational Science Foundation: Program in Decision, Risk, and Management Science, co-principal investigator, Product Liability Project 1989-1991
National Science Foundation: Program in Decision Risk and Management Science, co-principal investigator, Consumer Product Safety Project, 1990-1991
National Institute on Alcohol Abuse and Alcoholism: Youthful Drinking Project, 1992-1994
National Institute for Child Health and Development: Shannon Award, 1994-1995
National Institute for Child Health and Development: Pregnancy Outcomes Project 1996-1998
U.S. Veteran's Administration. "Informal Caregivers of Veterans with Dementia.: Costs, Quality of Life, and Service Use." 1997-2003
National Institute for Child Health and Development: Long Term Consequences of Abortion Funding Cutoffs, 1999-2001

PROFESSIONAL ACTIVITIES

Editorial Advisory Board, Journal of Risk and Uncertainty

American Economic Association, Econometric Society, Industrial Relations ResearchAssociation

Duke University: Faculty Compensation Committee, 1994-1996; Alcohol Policy Task Force, 1995; Sport Agents Committee, 1991-2001. Fuqua School of Business: Economics Area Coordinator, 1994-1998; Curriculum Committee, Admissions Director Search Committee, Health Care Management Committee; LEAD Program in Business, Curriculum Director 1993-1996

Ad Hoc Reviewer, *Journal of Political Economy, American Economic Review, Quarterly Journal ofEconomics, RAND Journal of Economics, Review of Economic Studies, Journal of Law and Economics; Review ofEconomics and Statistics, Journal of Risk and Uncertainly, Jour-nal of Health Economics, Journal of Environmental Economics and Management, Journal of Human Resources, Journal of Public Economics, Economic Journal, Journal of Labor Economics, Industrial and Labor Relations Review, Economic Inquiry*

Exhibit 2

Materials Reviewed

Sales information for real estate in the relevant market area was compiled from two sources. These sources include the following.

- "Comps" — file: "Banks Comparable Spreadsheet.xls", provided by Plaintiffs' counsel.
- "MLS" — Rapattoni MLS, Pages 1-13, dated 7/3/2009, provided by Plaintiffs' counsel.

Annual Reporttrri Section 111 Beach Nourishment Monitoring Program, FY-1999, January 2000.

John H. Banks, et al., Plaintiffs, v. The United States, Defendant, U.S. Court of Federal Claims 78 Fed. CI. 603; 2007 U.S. Claims LEXIS 318

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Fisher, Franklin (1980) "Multiple Regression in Legal Proceedings," *Columbia Law Review* 80(4):702-736.

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Rubenfeld, Daniel (1994) "Multiple Regression," in *Reference Manual on Scientific Evidence,* Federal Judicial Center, U.S. Government Printing Office, Washington DC.

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Exhibit 3

Price Per Lake Front Footage (PLFF) for Improved Lots

Unconditional Mean Price Comparison clan 27, 2000 Disclosure)

	Non-Erosion zone		Erosion Zone	
Treatment:	No Treatment		Treatment	
Pre/Post:	Pre	Post	Pre	Post
Treatment:	NO	NO	YES	YES
Pre:	YES	NO	YES	NO
Mean PLFF	$5,205	$11,194	$2,589	$6,281
Observations	30	53	6	18
Non-Erosion Difference	$5,989			
Erosion Difference			$3,692	
Non- Erosion Duff- Erosion Diff		$2,297		
Non-Erosion /Erosion Pre Diff		$2,616		
Non-Erosion /Erosion Post Diff		$4,913		

Exhibit 4A.1

Regression Output (Improved Lots Only)

Price per Lake Front Foot (Jan 27, 2000 Disclosure)

Source	SS	df	MS		
				Number of abs =	107
				9 4, 102) =	1332
Model	1,209,700,000	4	302,430,431	Prot. F =	0
Residual	2,316,200,000	102	22,707,780	R-squared =	0.3431
				Adj R-squared =	43173
Total	3,525,400,000	106	33,263,352	Root MSE =	4765.3

pplakefi	Coef.	Std. Err.	t		[95% Conf.	interval]
sqft	L37	0.45	3.04	0.0030	0.48	2_26
Post	5,871.82	1,089.42	5.39	0.0000	3,711	8,033
treatment mrlumpggsmpsp s4q	(2,277.41)	2,134.00	-1.07	0,2880	(6.51-9).	
	AgOttagelWilltk"		1"			
_cons	2,216.73	1,311.66	1.59	0.0940	385)	431

Exhibit 4A.2.

Regression Output (improved Lots Only)

Price per Lake front loot (Jan 27, 2000 Disclosure)

Source	55	df	MS
Model	1,852,000,000		308,573,003
Residual	1,673,900,000	100	16,738,773
Total	3,525,900,000	106	33,263,352

Number of obs =	107
9, 6, 100 =	18.44
Prob > F =	0
R-squared =	0.5253
Ad) R-squared =	0.4968
Root MSE =	4091.3

pplakeff	Cod_	Std. Err.	t	P>itl	[95% Conf.	Interval'
sqft	2.08	0.40	5.14	0.0000	1.28	2.88
post	5,90552	938.08	6.30	0.0000	4,044	7,767
treatment	(1,472.99)	2,859_49	-0.79	[illegible]	(5,162)	2,216
[illegible]	[illegible]	[illegible]	[illegible]			
dwff1	(2,793.16)	1,075.56	-2.60	0.0110	(4,927)	(659)
durff2	(5,266.27)	1,027.60	-6.10	0,0000	(8,305)	(4,228)
_cons	2,481.75	1,152_29	2.15	0.0340	196	4,768

* dwffl is a dummy variable =1 when wff > 100 and wit <=150, otherwise dwif1=0

** dwff2 is a dummy variable =1 when wff > 150, otherwise dwff2=0.

Exhibit 4A.3

Regression Output (Improved Lots Only)

Price per Lake Front Foot (Jan 27, 2000 Disclosure)

Excludes Salesprice 3,000,000 & Price per LLF < $1,000

Source	55	clf	M.5		
				Nu mher of obs	102
				F(6, 95) =	16.82
Model	1,666,200,000	6	277,692,907	Prob > F	0
Residual	1,568,700,000	95	16,512,469	8-squared =	0.5151
				Ad; 8-squared =	0.4844
Total	3,234,800,000	101	32,028,138	Root M5E	4063.6

pp lakeff	Cod,	Std. Err.	t	P>ltl	[95% Conf.	Interval]
sqft	1.81	0.46	3.89	0.0000	0.89	2:73
post	5,758.83	954.80	6.03	0.0000	3,863	7,654
treatment	(1,075.55)	Z065.21	-0.52	0.6040	(5,176)	3,024
MMERMIM7:110M1021701 .:11.ffirreatritiallIRDDIENkiindliiiiTSMA$1*						
dwffl	(2,666.95)	1,098.73	-2.43	0.0170	(4,848)	(486)
dwff2	(6,518.83)	1,064.47	-6.12	mom	(8,632)	(4,406)
_cons	3,179.23	1,274.19	2.50	0.0140	650	5,709

* (Neil is a dummy variable =1 when wff > 100 and wff c=150, otherwise dwffl=0
dwff2 is a dummy variable •=1 when wff > 150, otherwise ciwff2=0.

Exhibit 4B.1

Regression Output (Improved Lots Only)

Log(Price per Lake Front Foot) (Jan 27, 2000 Disclosure)

Source	55	df	MS		
				Number of obs =	107
				F(4, 102) =	133
Mode)	26.0473	4	6.5118	Prob > F =	
Residual	49.1922	102	0.4823	R-squared	0.3462
				Adj R-squared =	03206
Total	75.2395	106	0,7098	Root MSE	0.69446

Ipplalceff	Coef.	Std. Err.		o.P>Iti	(95% Conf.	interval]
Isqft	0.381	0.157	2.42	00170	0.069	0.693
post	0.927	0.159	5.84	0.0000	0.613	1242
treatment	{0399}				(1,020)	0.222
ETWAYM,WW	Jem	Air		Ifti	urriorivAtfr;c.	
eons	5313	1.207	4.40	0.0000	2.919	7.707

bathymetric data available for the south east shore and incorporated in the sediment budget investigation.

Table 2.1 Historic and Recent Barhymetnc Data

Year	Agency	Survey Method	Spatial Extent
1945-46	NOAA	Track Lines	Berrien County
1964-65	NOAA	Track Lines	Berrien County
1991	NOAA	Track Lines	Berrien County
1995	USACE	SHOALS Lidar	N and S of St. Joseph
1999	USACE	SHOALS Lidar	South of St. Joseph
2001	USACE	SHOALS Lidar	South of St, Joseph
1999	USACE	SHOALS Lidar	Warren Dunes
1999	USACE	SHOALS Lidar	New Buffalo

Figure 23 below presents the raw soundings for the 1945-46 NOAA data and the 1995 SHOALS Lidar points at St. Joseph. The most obvious distinction between the two data types is the density or spacing of the actual soundings. The SHOALS points are separated by 1 to 20 m, while the 1945-46 points from the Track Lines are spaced at 100 to 200 m. These significant differences in data density represent challenges for generating 3D grids in GIS and completing historic to recent bathymetry comparison. These issues are discussed further in Section 3.0.

Although the SHOALS surveying technology has the potential to provide extremely dense data coverage, there are several limitations with the current technology, including: 1) often poor coverage at the harbor mouths due to water clarity issues, as seen in Figure 2.3 (data collection is critical in these areas), 2) highly variable spatial coverage (for example, there is very little overlap between the 1995, 1999 and 2001 SHOALS surveys at St. Joseph), and 3) unreliable results in the swash zone due to turbulence from breaking waves (this shallow nearshore zone is often the most important region for data collection).

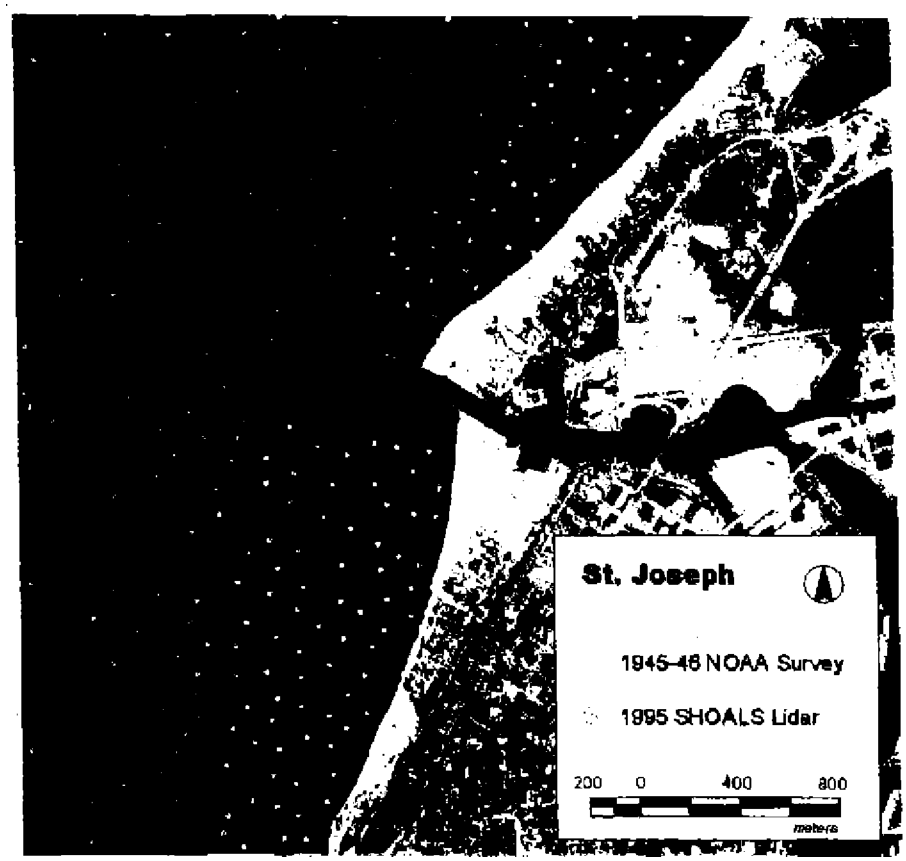

Figure 2.3 Camper!son of Barhymstric Data Sources at SL Joseph (NOAA Track Lines vs SHOALS Lidar)

2.3 2D Beach Profiles

Although the spatial coverage is limited to the actual shore perpendicular profile, 21) beach profiles still represent a valuable and reliable method of **data** collection for lake bed and beach change analysis. In the spring of 2001 the USACE completed an extensive profile data collection initiative at the harbors on the south east shore of Lake Michigan. The beach profiles extended north and south of the following harbors: Grand Haven, Port Sheldon, Holland, Saugatuck, St. Joseph and New Buffalo (refer to Figure 1.2). The offshore extent of the profiles ranged from 8 to 15 m in depth. Figure 2.4 provides an example of the spatial coverage at St. Joseph.

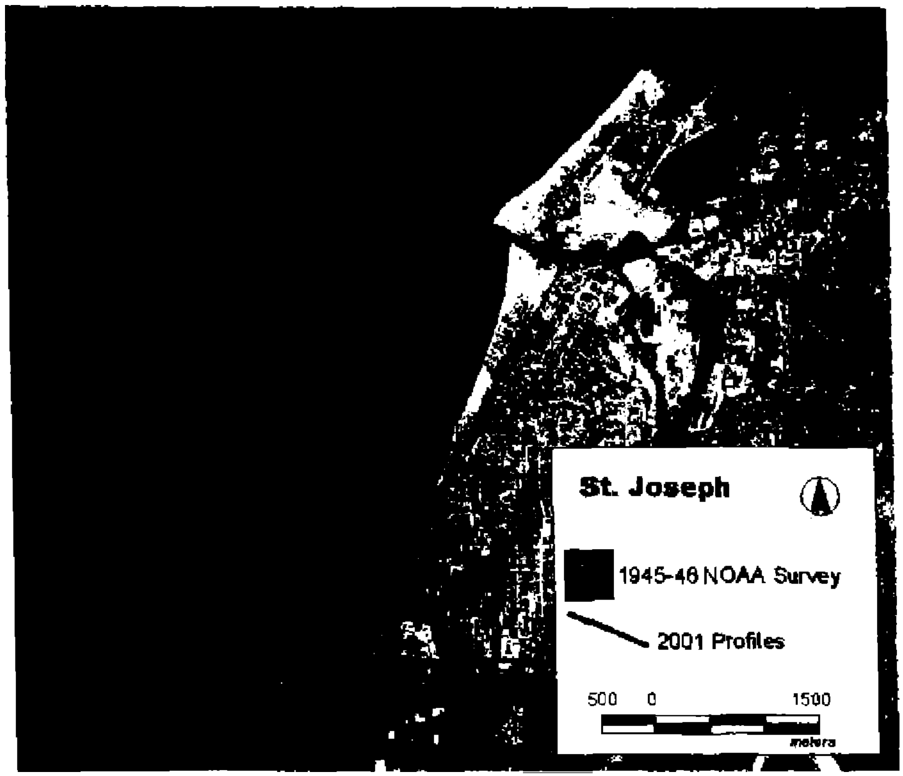

Figure 2.4 Historic NOAA Track Lines and 2001 Acoustic Profiles at St. Joseph, Berrien County

2.4 Artificial Beach Nourishment

Historic dredging and beach nourishment records from the Operations and Maintenance Divisions of the USACE District Offices were assembled and reviewed for the Lake Michigan Potential Damages Study. The database is organized by the 1 km shoreline reaches that characterize the shoreline and include both dredging and placement volumes and material trucked to the shoreline from upland sources.

Accurate records appear to only be available for the last 20 or 30 years. Prior to this period, most of the dredged material from, navigation channels was dumped in deep water or placed in a confined disposal facility. This material is permanently lost from the nearshore zone. The sediment that is trucked from upland deposits and placed on the beach is also an important source, as it represents new material for the littoral cell.

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Department of Justice

Environment and Natural Resources Division

Terry A1. Pekit Allai'M
Doi & Field office
1P61 graham 8 Floor
Dottier. CD 89294

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April 16, 2010

BY MAILAND F

Asses, Peterson, Esq.
Christensen & Ehret LLP
222 West Adams Street
Suite 2170
Chicago, IL 60606

RE: Banks... at al. d States. No. 99-4451 L

Dear Assets:

Please provide the following information regarding Dr. Charles W. Shebica's "Shoreline Erosion Protection Berrien County, Michigan" (Shoreline Erosion Protection) report dated April 6,2010, and Dr. Micheal J. Chrzastowski's report, "Headland Beach Systems; The Most Effective and Sustainable Shore Protection for kasiderdial Lakefront Properties Dow▶drift from the Jetties at St. Joseph, Michigan" (Headland Beach Symms):

1. Dr. Shabica's "Shorellno Erosion Protection" reoort:

   A. All information considered by Dr. Shabica that supports his statement that "Regional beach nourishment is no longer considered a viable coastal management solution for sediment-starved regions in Illinois and Michigan." aog Shabica report at page 5 (bottom pangmph).

   B. All information considered by Dr. Shabica that supports his deicription of "intensive monitoring" as stated on page 6 of his report. This should include but is not limited to describing what those "Intensive monitoring" efforts consisted of and any documentation associated with the efforts.

   C. Copies of the studies of Resio and Vincent, 1976, and Iubertz, at al.1991, which are referenced by Dr. Shabica on page 7 of his report.

   D. From Dr. Shabica's assumptions listed on page 7 of his report, please provide:

      (1) The "elevation of cohesive sediments at toe of structure."

DEPOSITION EXHIBIT Shabica 3

PENGAD 800-631-6989

PLAINTIFFS EXHIBIT

(2) **The "maximum depth at breakwater toe Ds — below Design High Water."**

(3) The "Design Wave Hs"

The **last two items had to be known items in order to formulate the table on page 10 of Dr, Shabica's report.**

B. **For the "Headland** Breakwater **Specifications" listed on page 8 o f his report, please provider**

(1) **The calculations used by Dr. Shabica to arrive at his average armor size estimate of 7.5 tons.**

(2) **The calculations used by Dr. Shabloa to arrive at this "B" Stone estimate of 1000 'bate 20110 lbs.**

(3) Did Dr. Shavina **apply the 7.5** ton **eatiroate to both his revetment and breakwater stone quantity estimate calculations? Sea** "Stone Quantity Estimates **for Revetments and Toe Stone (per linear R.)" on page S.**

F. Provide the cross-sections for all structures with crest **end toe elevation assumptions and** layer thickness, **Szt page 8 of Dr. Shabica'a report.**

0. **For the "Construction Cost Estimate Assumptions" —= pap 9 of his report— please provide** copies of all back-up cost intimation **for.unit costa arid fix rate items.**

H. **Per the table an page 10 of Dr, Shabica's report, please provide the caloulatioas (formulas and inputs), to include copies of any documents that provided the support for the** inputs, for **each of the tabulated results for the entries in the columns labeled "Headland Beach,"** "Quarrystone Revelment," and **"Step Revetment.'**

I. Provide copies of **the documents or materials or information relied upon by Dr. Shabica to arrive at the estimated cost of $1,500,000 for a physical hydraulic model described on page 11 of his** report.

J. **For the "Nearshore Headland Beach Systems Specifications and Cost Est.. for 22,000** *SO,* page I l **of his report —please provide:**

(1) **The conceptual design drawings for this system.**

(2) The calculations **and/or bases for the** quantity estimates for the steel groins, stone **placement, and Bridgman Lake Sand entries.**

-

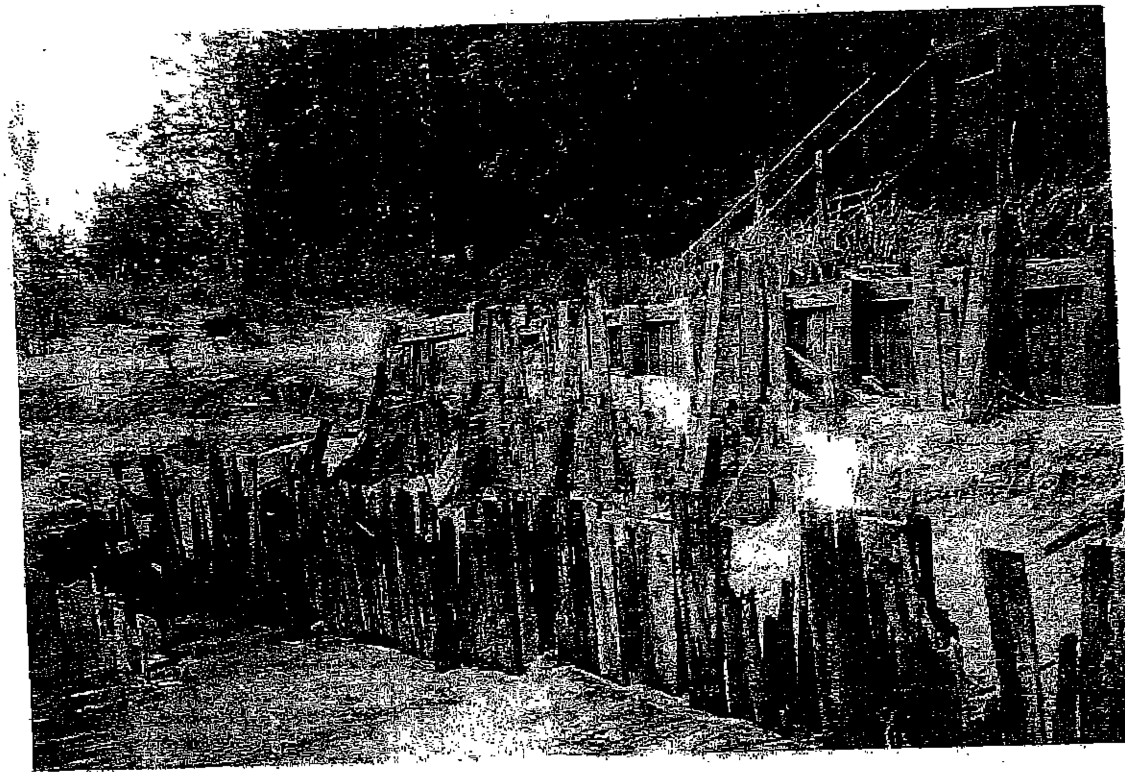
2, **<u>Dr—Chrzastowskils "Headland Beach SystemeIroort;</u>**

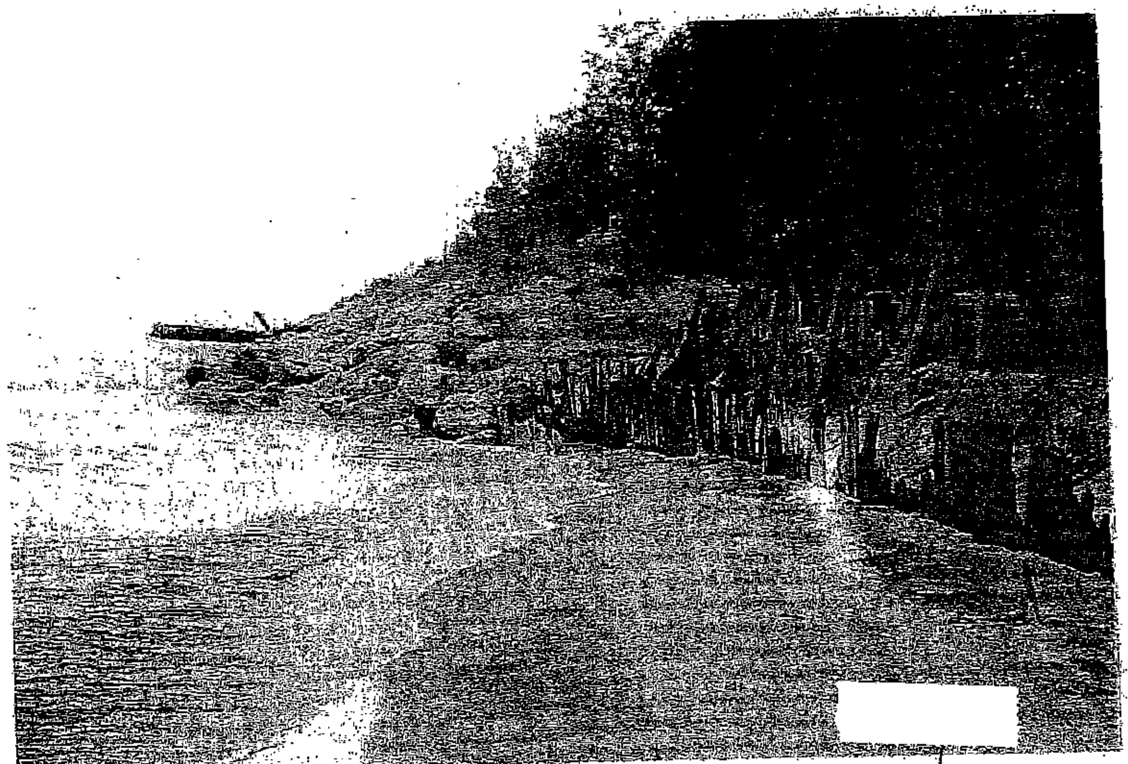
A. **Please provide all information that Dr. Cbrzastowski considered** that supports **his statement that headland beach systems have proven to be "durable, adaptive, and east effective." Bs& page 5 of Dr. Chrzastowski's report,**

Sincerely.

Terry M. Petrie

Terry Panic
Trial Attorney





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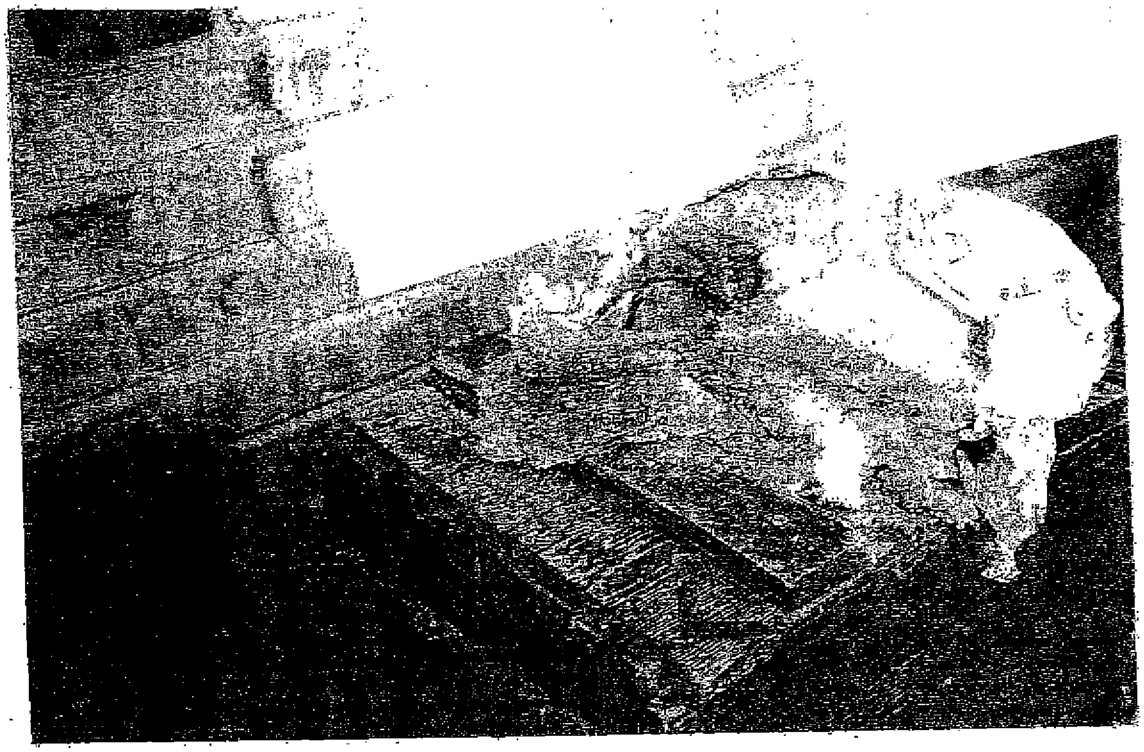

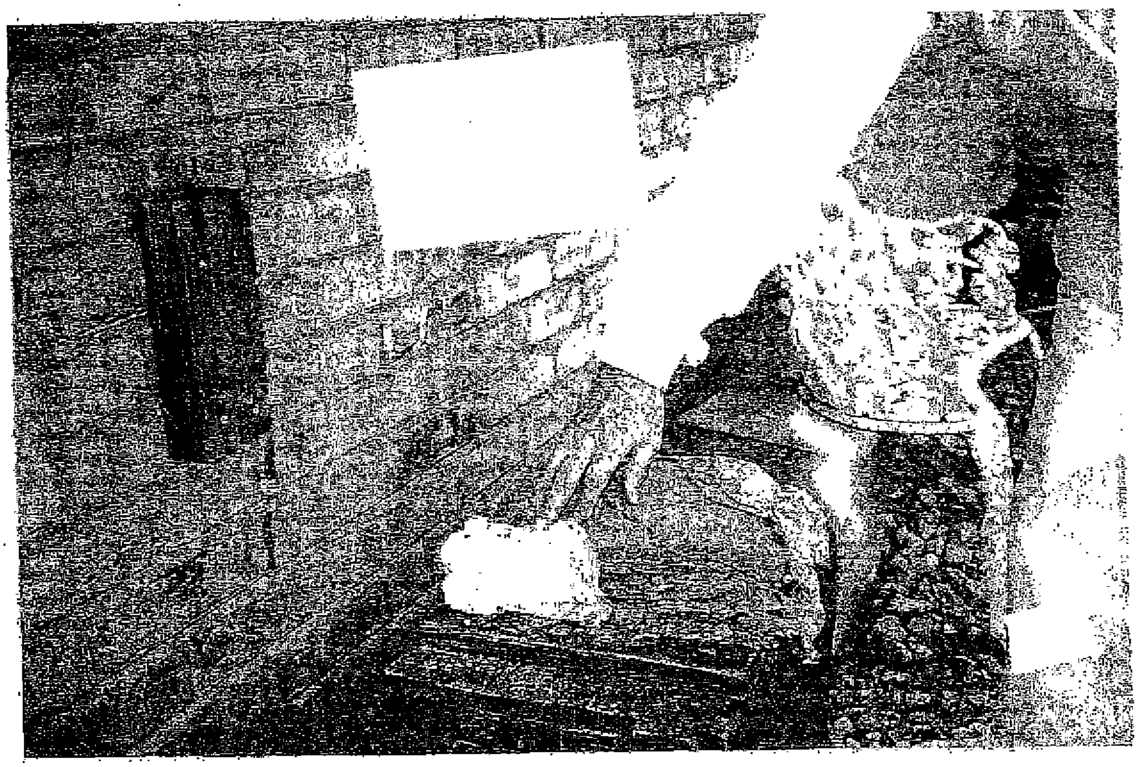

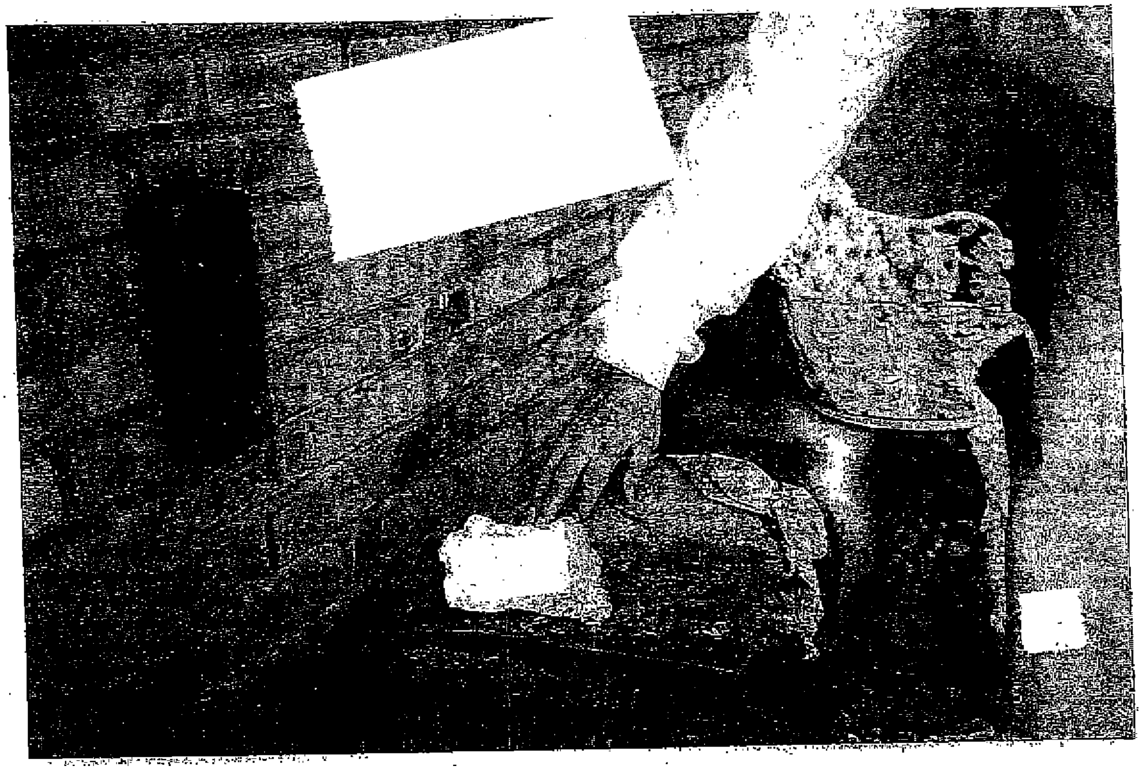

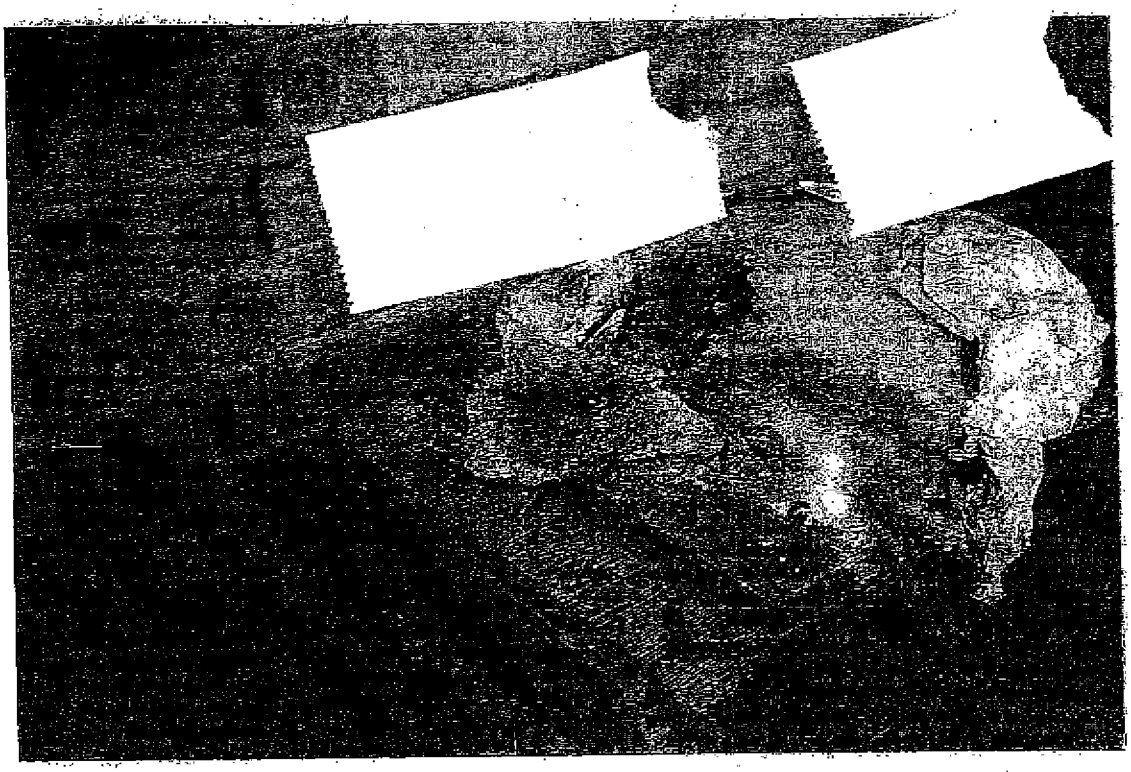

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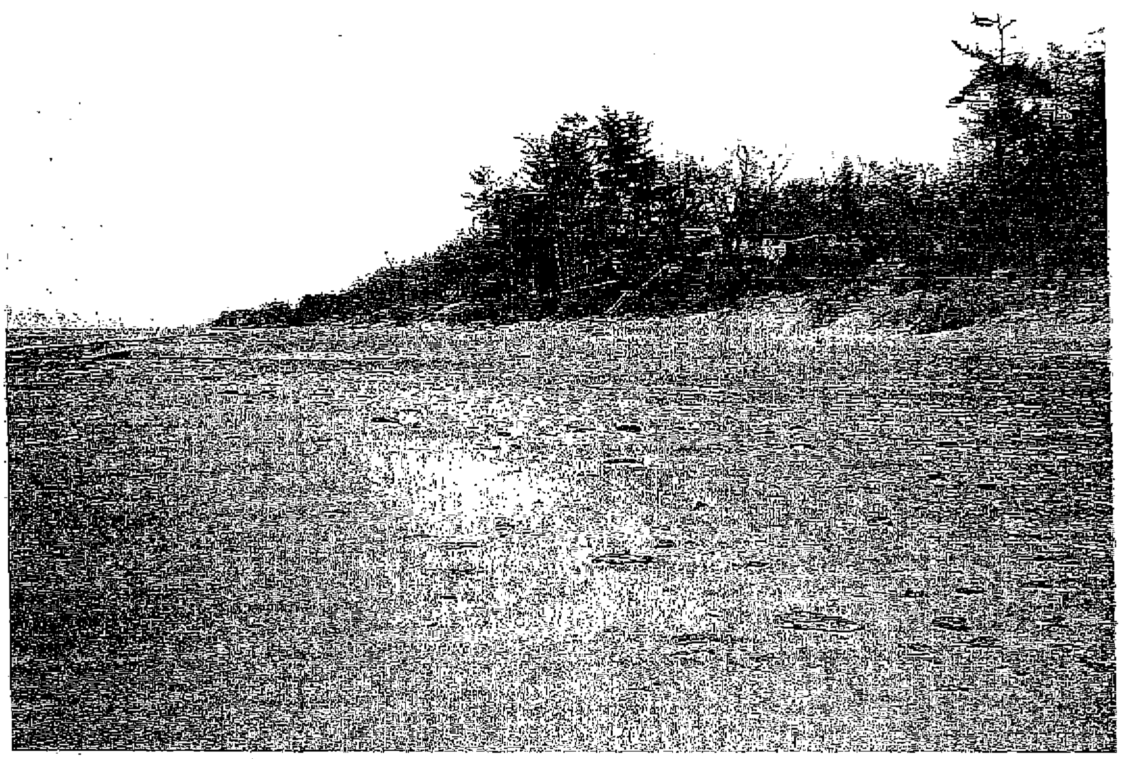

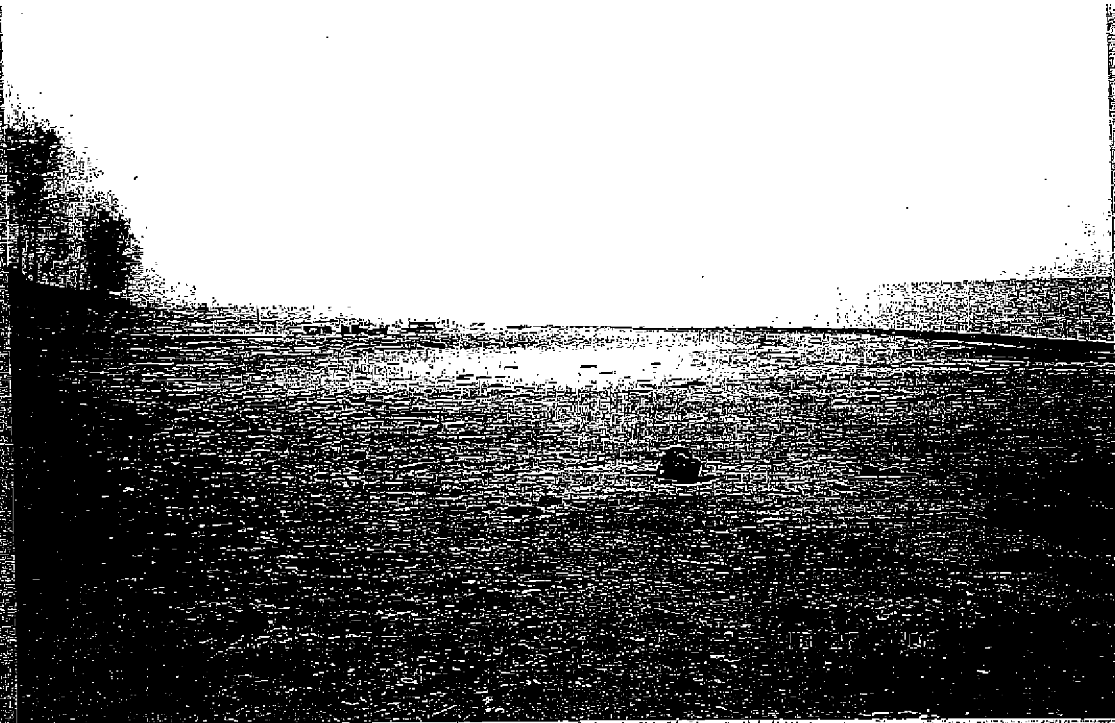

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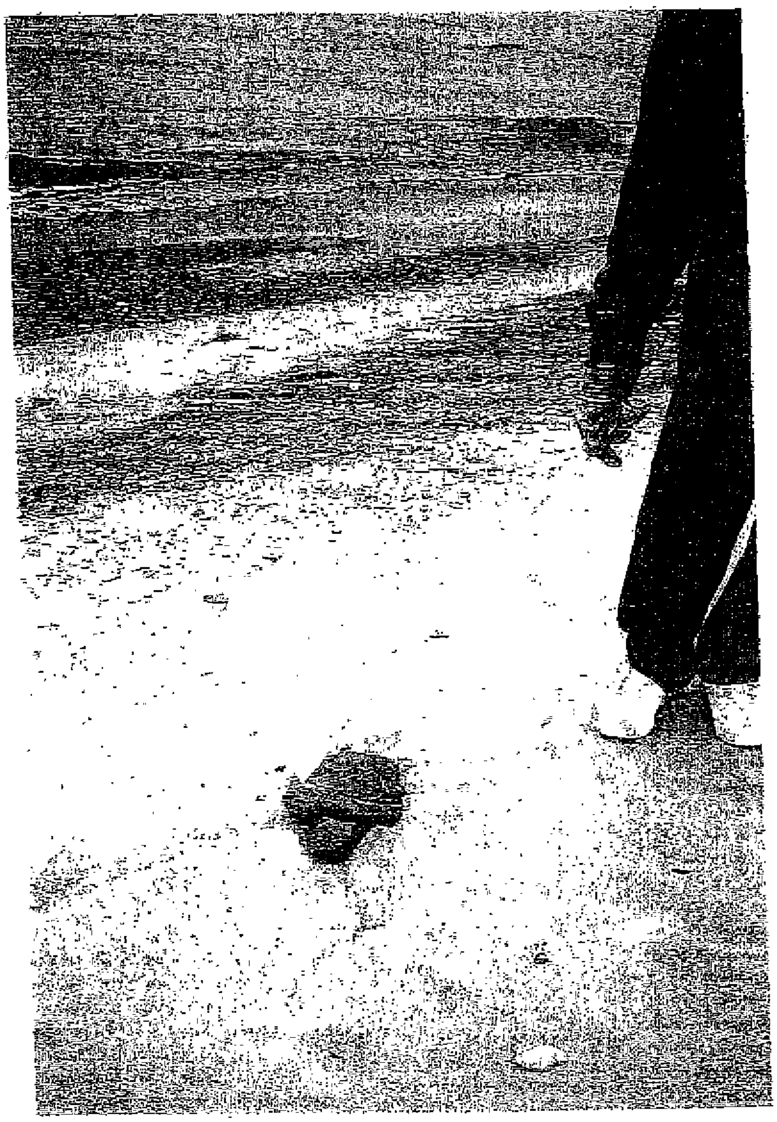

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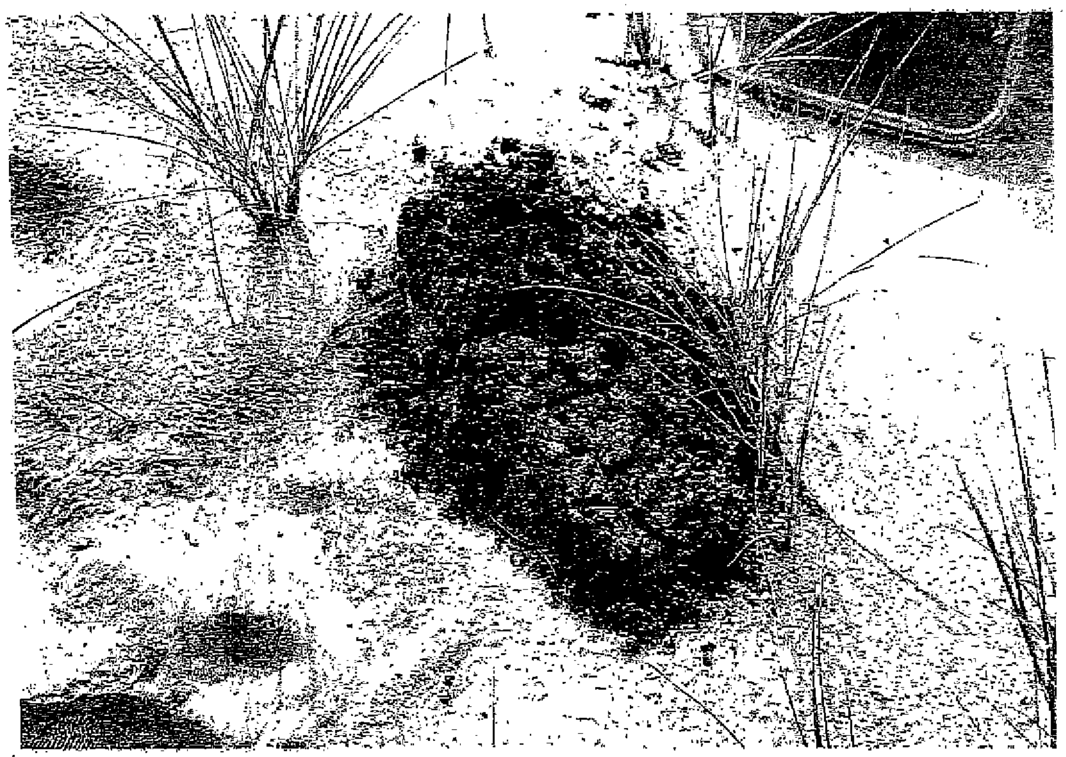

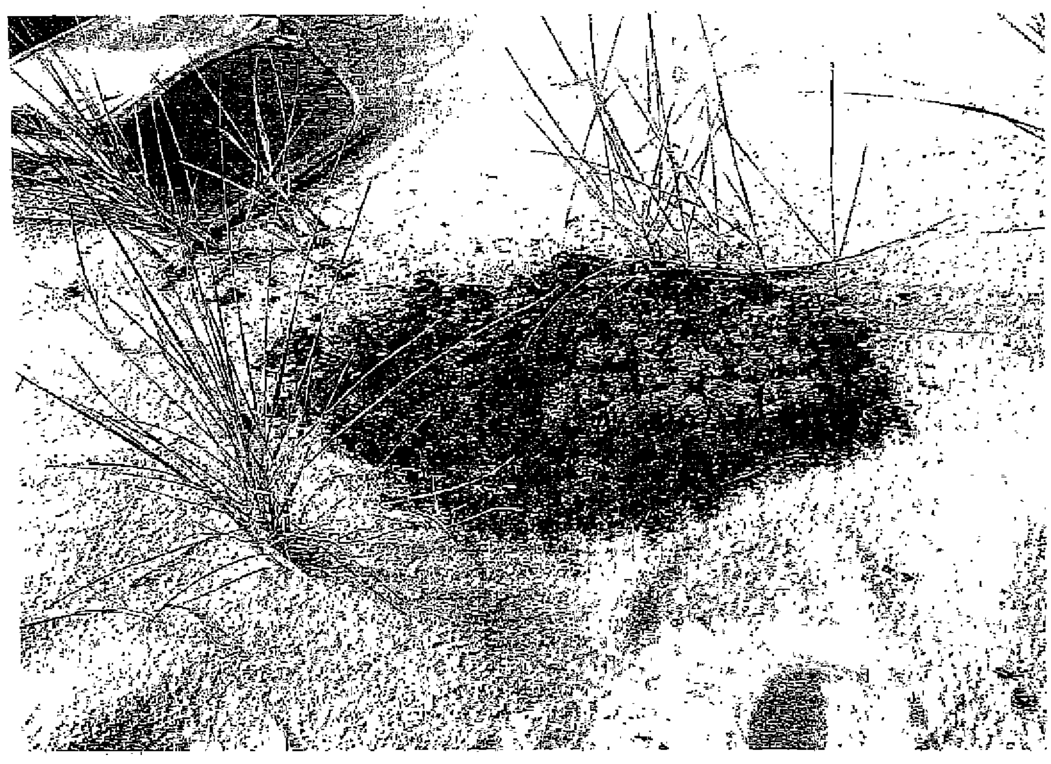

Chapter 111-5
Erosion, Transport, and Deposition of Cohesive Sediments

111-5-1. Introduction

a. Cohesive sediments are those in which the attractive forces, predominantly electrochemical, between sediment grains are stronger than the force of gravity drawing each to the bed. Individual grains are small to minimize mass and gravitational attraction, and are generally taken to be in the silt (<70 *o)* to clay (<4 /..4) range. The strength of the cohesive bond is a function of the grain mineralogy and water chemistry, particularly salinity. Thus, a. coarse silt behaves like noncohesive fine sand in fresh water, but is cohesive in an ocean environment. Similarly, a fine sand exhibits cohesion in salt water. In other words, it is easier to define cohesive sediment by behavior than by size.

b. Grain size and shape nevertheless play a significant role in the lack of permeability of cohesive sediment. As grain size decreases, so does the size of the interstitial pore spaces while drainage path length increases. The small pores result in greater resistance to flow, exacerbating the effects of the long drainage path. Clay minerals tend to form flake-shaped platelets, rather than spherical particles. These platelets deposit with the smallest dimension vertical, further reducing pores and increasing vertical drainage paths. For this reason, clay is often used as an impermeable layer in hydraulic earthworks such as dikes and channels.

c. In coastal engineering terms, the principal indicator of cohesive sediment behavior is a critical shear for erosion of bed sediment which is significantly greater than the critical shear for deposition r„ In other words, once the sediment has been deposited on the bed, the cohesive bond with other bed particles makes it more difficult to remove than particle mass alone would suggest.

d. The processes and states of coastal cohesive sediment listed below are shown schematically in Figure 111-5-1 and Table III-5-1.

(1) Consolidated. Stiff or hard cohesive sediment that has had centuries to drain, probably compressed beneath glaciers or other overburden.

(2) Suspension. Individual grains or flocs dispersed in the water column and transported with the water.

(3) Fluid Mud. A static or moving intermediate state between suspension and deposition, analogous to bed-load transport of noncohesive sand, that can move in the direction of flow supported by the bed. Fluid mud is the result of excess pore pressure, built up by hindered settling or wave action. Water cannot escape from the sediment deposit, and builds up the excess interstitial pore pressure necessary to support the weight of sediment above it. The whole mass of sediment and trapped water behaves like a uniform dense viscous fluid, flowing downhill or in the direction of the water flow. Fluid mud layers can often be seen on echo soundings as a false bottom in depressions in the seabed.

(4) Mud. Unconsolidated cohesive sediment that has been recently deposited. 'Recently' may be a matter of a few hours to several years.

e. Processes and states in Figure III-5-1 may be skipped. For example: most coastal mud, even fluid mud, is eroded before it has undergone sufficient consolidation to be defined as `consolidated'; many cohesive sediments do not form fluid mud, but deposit directly as stationary mud. Differences between mud and consolidated sediments occur during erosion. Transport, deposition, and consolidation are the same for both mud and consolidated cohesive sediments.

Figure 111-5-9. Sand beach disappearing into mangrove on the island of Borneo. Sediment within the mangrove is cohesive mud

b. Consolidated cohesive sediment is eroded by at least four mechanisms:

(1) Through abrasion by sand particles moved by waves and low currents.

(2) Through pressure fluctuations associated with turbulence generated at various scales such as wave-breaking-induced turbulence that reaches the lake or seabed and large-scale eddies that may develop in the surf zone.

(3) Through chemical and biological influences.

(4) Through wet/dry and freeze/thaw cycles where exposed to the atmosphere.

c. Sand can also provide a protective cover to the underlying cohesive substratum. However, only when the sand cover is sufficient to protect the cohesive substratum at all times will the shore revert to a sandy classification (i.e., truly a 'thick pile of sand').

d. On consolidated cohesive shores, the rate of lake or seabed downcutting determines the long-term rate at which the bluff or cliff retreats at the shoreline. In other words, while subaerial geotechnicai processes may dictate when and where a slope failure will occur, the frequency of failures over the long term is determined by the rate at which the nearshore profile is eroded (i.e. the downcutting rate). Subaqueous and subaerial erosion processes on cohesive shores are discussed in detail in Part 111-5-7. In addition, the geomorphology of cohesive shores and the relationship to erosion processes is the topic of Part 111-5-5.

A.

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profile upstream and downstream of the sample in order to determine the shear stress applied to the sample by the flow. Cornett, Sigouin, and Davies (1994) describe a similar approach using a tilting flume for the analysis of samples extracted from the bed of Lake Michigan near St. Joseph Harbor (Parson, Morang, and Nairn 1996). In this case, a laser doppler velocimeter measured the velocity profile near the bed in order to establish the shear stress applied to the sample by the flow (Figure III-5-16). This figure shows a sand veneer migrating over the till sample in the unidirectional flow flume. In both the Karnphuis (1990) and the Cornett, Sigouin, and Davies (1994) tests, the maximum flows generated were in the range of 3 to 3.5 &sec (10 to 12 ft/sec). Results from experiments using this technique to estimate erodibility are presented in Part III-5-7b.

Figure III-5-16. Laser doppler velocimeter (LDV) used to determine shear stress exerted on the till bed in a unidirectional flow flume test. This test features sand in the flow acting as an abrasive

(f) The most realistic approach that can be taken to assess erodibility in a laboratory setting is to create a nearshore profile with intact and undisturbed cohesive sediment samples in a wave flume or basin. This approach was used by Skafel and Bishop (1994) to complete important research into the erosion processes on cohesive shores. Intact samples, measuring I m by 0.35 m by 0.45 m, encased in an open-ended steel box were extracted **from** the **top** of a bluff on Lake Erie and placed directly in a wave flume. The open-ended steel box was pushed slowly into the till by a 20-ton hydraulic ram and the till at the inner end of the box was cut away using a chainsaw with a trenching chain. The box was then removed with a crane. The till boxes were installed in the flume to create the desired profile shape. In these tests, the effects of sand cover in the form of migrating bars or a patchy veneer were tested. Also, the influence of breaking waves on the erosion of the cohesive sediment was assessed.

(3) Field techniques for assessing surface and subsurface conditions.

(a) One of the most important pieces of information in characterizing a cohesive shore profile is the sand cover thickness across the underlying cohesive profile (i.e., measured from the bluff toe out to a depth of at least 4 in). In addition, where the cohesive profile is exposed, it is also important to determine whether or not a protective lag deposit exists. As with any coastal engineering site investigation, beach and nearshore profiles are essential information. In this section, a variety of techniques for characterizing the surface and subsurface conditions, with particular focus on the sand cover thickness, are presented, ranging from the simplest to the most sophisticated.

(b) The simplest technique of estimating the thickness of the sand cover across the profile involves the following tasks:

- Complete a beach and nearshore profile from the toe of the bluff out to the depth of closure (between the 5- and 10-m water depth).

- Through the use of a steel probe or test pits, attempt to determine the thickness of sand cover near the waterline.

- Estimate the shape of the underlying cohesive profile (as a smooth exponential form) joining points between the toe of the bluff, the position of the till at the waterline (if determinable), and the troughs between the bars on the profile. Typically, the till will be exposed or only thinly covered in the troughs. If repeated profiles are available at a site, these may provide additional information on the position of the underlying till if the position of the troughs between bars shifts between surveys.

(c) In order to complement the simple technique described above, a diving inspection could be completed across the profile. The diver could use an underwater video to document conditions, and a steel probe to estimate sand cover thickness at different locations. Depending on the extent of sand cover, the till may be exposed in some areas. Alternatively, a frame-mounted video camera lowered from a boat or a remotely operated vehicle with video could be used. Video is also valuable in assessing whether or not a lag deposit exists where the cohesive layer is exposed.

(d) In place of a simple steel probe, a jet probe could be used to survey the thickness of the sand cover on the land and underwater. A jet of either water or air can be used to penetrate the sand cover (the latter is only applicable underwater). Shabica and Pranschke (1994) describe the use of a hydraulic probe consisting of an extendible 20 mm diameter pipe through which water is pumped at 2.8 kg/cm^2 (40 psi).

(e) A technique based on electrical resistivity has been used to establish the sand thickness across the subaerial section of beach for sections of the Holderness shoreline. This method is particularly useful at locations with large tidal ranges that allow for significant sections of the profile to be surveyed at low tide.

(f) Ground-penetrating radar was used to survey the thickness of the sand cover for several profiles downdrift of St. Joseph Harbor (Parson, Morang, and Nairn 1996). The limitation of this technique is that it can only be used in a freshwater environment.

(g) Sub-bottom profiling, or high-frequency seismic imaging, is another geophysical technique that is capable of establishing the thickness of sand cover over an underlying cohesive profile. Side-scan sonar is an acoustic technique that provides an image of the seabed or lake bed surficial conditions. While this procedure would not be capable of determining the thickness of sand cover, it could provide useful surficial information such as the extent of exposed gravel and cobble lag deposits. These methods are described in Part IV-5 in greater detail.

A

Grit

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St. Jes■ph, Mich. 49055
Office: (6161 933-0677

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6-26-85	Per: Quote # 6

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9047 North Mason Ave.
Morton Grove, Illinois
60053

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QUANTITY	DESCRIPTION	UNIT PRICE	AMOUNT
	Work At: Property at 2930 S.Lakeshore Dr. St. Joseph, Mich. 49085		
	Job Completed on: 6-25-B5		
	To furnish and install or place concrete Rip-Rap at above address: Lump Sum;		$6,000.00
	(Less Down Pirit:)		-3,000.00
	Balance Due:		T3,OULLUU
	Thank You So Much.		
	A Service Charge al the rma M 1¦e/. per MbMh Oa% per annum) will be charged on all accounts over 30 days past due.		

Please pay from this Invoice — No statement will be rendered

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Mrs. Marsha Wineberg
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We are pleased fp *quote* on •the *following, subject fo ibe terms hereln*

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215 Lineal Fr	@ 102.00 per lin. ft. to place bloeks for shore protection. (210.00 x 100.08 21,000.00)Note: below	$21,000.00 .

Note: 1/3 required deposit to begin work and:
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Exalt/010n: This proposal expires If not accepted within 30 days of this proposal date. A service Charge el ihe rate of 11/2 % per month 1113% par annum) will be charged on the unpaid balance over days peal due.

Proposal Accepted:

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Quotation No.: 1001

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George Jo porren,(Pjesldent

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202EIXEOXICIPDinta 1223 Broad St.
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Phone (616) 9133-0677

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ST. JOSEPH. MICH. 19085
OFFICE, (616) 983.0677

To

Hirete A. Wineherg
9047 North Mason Avenue
?4orton Grove, Illinois
60053

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Wa crre plepeed le quote *on the loliowinn, subleal in the lermm* here!]]:

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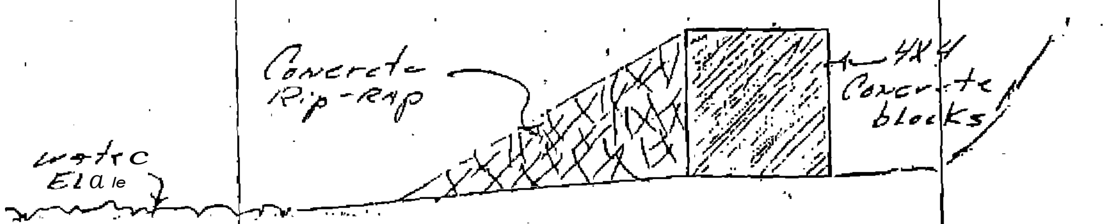

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COASTAL ENGINEERING MANUAL

GUIDE FOR PREPARATION OF THE COASTAL ENGINEERING MANUAL

by

Andre Szuwalski

and

Joan Pope

Coastal Engineering Research Center

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-45199

February 1993

Draft Report

r f)

Chapter I-.J.
Introduction

General

The CEM is a CERC- wide effort to update and expand the.outdated *Shore Protection Manual* (SPM) and to supersede other specialized Corps engineering manuals on coastal, topics. Like other engineering manuals, the. CEM must be practical, easy to use, and presented in.a manner that enables users to eatily develop a procedure for resolving coastal project related, problems,

1-1-2. Purpose of the CEM

There exists a need for a single, state-of-the-art technical document which 'incorporates the tools and procedures used to plan, design, construct, and maintain coastal projects. The current SPM no longer reflects present technological development in the field. of coastal engineering, The purpose of the CEM project is to develop an engineering manual whiCh includes the basic principlet of coastal processes, method's for oemputing coastal engineering planning and design parameters, and guidance on how to formulate and conduct studies in. support of coastal flooding, shore protection, and navigation projects: The CEM is intended to provide broader coverage at all asPettS of Coastal engineering than is found in the RPM, New sections Will be added on navigation and harbor design, dredging and disposal, structure repair and rehabilitation, wetland an.d low energy shore protection, risk analysis, field instrumentation, numerical simulation, and other topics. Major advances in coastal hydrodynamics and sediment transport, over the last 20 years will be addressed in the CEM. A particular challenge of the CEM will be to integrate the expanding array of computer-based tools into the fundamentals of good coastal engineering practice.

The CEM will be a living document and continually revised to reflect improvements as they are developed,

Target User

The CEM should be written at a level suitable for the USAGE District, BS-level graduate civil/hydraulic engineer who has, no advanced academic training in coastal engineering and its related subjects. Although the CEM will be used primarily by Corps engineers, it is expected this manual, like the SPM, will also be used by coastal engineers and other specialists in academia and industry in many parts of the world.

Prom: Dan Tilton <dtiitan@ectinc.com>
To: Scott Parker <sparker@ectinc.corn>, "John O'Meara (jarneara@ectinc.com)" <jorneara©ectinc.corn>, "Marc Florian (mflarian@ectinc.corn)" <mflorian@ecrinc,corn>, "labailey©ectinc,coml" <abailey@ectinc.com>
Date: **01/04/2008 08:55 AM**
Subject: RN: RE: **St** Joseph Dredging

Here is the opinion of the status of the sediment.
Don

 - - Original Message - -
From: Larry Poynter [mailto:poynterl@michigan.crov]
Sent: Friday, January 04, 2008 8:32 AM
To: dtilton@ectinc.com
Subject: Fwd: RE: St. Joseph Dredging

How's that' for service? LDP

>>> Duane Roskoskey 1/4/2008 8:26 AM >>>
Larry, the analytical results for this proposed project indicate that the sediments associated with this project are uncontaminated. As such, the WHMD would not regulate the upland placement of the material. If I can be of further assistance let me know.

Duane Roskoskey, P.E.
Department of Environmental Quality
Waste and Hazardous Materials Division
PO Box 30241
Lansing, Michigan 48909
Phone: 517-335-4712
Fax: 517-335-2245
E-mail: RoskoskOMichigan.gov

>>> Don Tilton <dtilton@ectinc.com> 1/3/2008 10:33:00 AM >>>
Larry,
Although a previous permits (DEQ #00-11-0026-P)had been issued for this project area, we went ahead and got samples from the project area. The attached map and analytical summary will show where we collected samples and what the results showed.
We are working on a date for everyone and a location and hope to have an email out soon.
Thanks,
Don

 - - Original Message - -
From: Larry Poynter t.mailto:povnterl@michigan.govl
Sent: Thursday, January 03, 2008 9:24 AM
To: dtilton@ectinc.com
Cc: Jeffry Fritsma;. Duane Roskoskey; Ernest Sarkipato

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STEVE ANALYSIS
ASTM D422

Client Name: ALS e-Lab Analytical Services

Project Name: 0711546 Project Na.: 0710167.4A

Date: 12/3/07 Technician: Dan Marlor

Soil Description: Fine to Medium Sand, Trace Coarse Sand, Trace Organics (Shells)

Sample ID.: PS-1 Sampled By: Client Source: Sediment Sample

Sieve Size	Retained Fractional Weight	Retained Fractional Percent	Percents Cumulative Retained	Percents Cumulative Passing	Spec.
3"					
I"					
3!'4"					
.I/8"					
#4	0.0	0, 0	0.0	100.0	
#8	0.7	0.1	0.1	99,9	
#10	0.5	0.1	0.2	99.8	
#16	8.2	1.8	2.0	98.0	
#30	95.0	20.7	22.7	77,3	
#40	157.6	34.4	57.1	42.9	
#50	154.4	33.7	90.8	8.2	
#100	41.2	9.0	99.8	0.2	
#200	0.2	0.1	99.9	0.6	<5.0
Pan	0.1	0.0	99.9		
LBW	0.5	0.1	100.0		
TOTAL	458.4	100.0			

Initial Weight 0f sample	458.4	gm	
Weight After Washing	457.9	gm	
LOSS By Washing (Clay & Silt)	0.5 gm	0.1%	
Fineness Modnius	—		
Crushed Material	---	gm	%
Organic Plate No.	--		
Clay-Ionstone	-----	gm	
Solt Panicles Including; (i) Clay-ITunstane	----	gin	%
(.2) Chen.	—	gm	%
Stan of (1) + *(2)*	---	gm	%

REMARKS:

Material meets MDEQ specifications for dredge material (greater than 95% retained on #200 *sieve)*

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SIEVE ANALYSIS
ASTM D422

Client Name; ALS e-La1 Analytical Services

Project Name: 0711546 Project No.: 0710167.4A

Date: 12/3/07 Technician: Dan Marlor

Soil Description: Fine to Medium Sand, Trace Coarse Sand, Trace Organics (Shells)

Sample LD.: PS-2 Sampled By: Client Source: Sediment Sample

Sieve Size	Retained Fractional weight	Retained Fractional Percent	Percents Cumulative Retained	Percents Cumulative Passing	Spec.
3"					
1"					
3/4"					
318"	0.0	0.0	0.0	100.0	
#4	0.7	0.1	0.1	99.9	
#8	3.7	0.8	0.9	99.1	
#10	1.4	0.3	1.2	98.8	
#16	15.2	3.2	4.4	95.6	
#30	107.6	22.5	26.9	73.1	
#40	128.8	27.0	53.9	46.1	
#50	156,6	32.9	86.8	13.2	
#100	61.1	12.8	99.6	0.4	
#200	1.0	0.2	99.8	0.2	<5.0
Pan	0.7	0.1	99.9		
LBW	0.4	0.1	100.0		
TOTAL	477,2	100.0			

bide Val& of SaLoPle	477,2 _gm		
Wei ght Afrm. Washing	476,8 gm		
Lass By Washing (Clay & Silt)	0.4 gm	0,1%	
Fineness Modu1a	----		
Crushed Material	— -	gm-	96
Organic Plate No.	— —		
Clay Ironstone	-----	gm	%
Soil Particles Including: (I) Clay-Ironstone	—-	gm	%
(2) Chert	—-	gm	%
Sum of (1) + (2)	---	gm	%

REMARKS:

Material meets MDEQ specifications for dredge material (greater than 95% retained on #200 sieve)

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SIEVE ANALYSIS
ASTM D422

Client Name; ALS c-Lab Analytical Services

Project Name: 0711546 Project No.: 0710167.4A

Date: 12/3(07 Technician: Dan Manor

Soil Description; Fine to Medium Sand, Trace Coarse Sanri, Trace Organics (Shells)

Sample I.D.: PS-3 Sampled By: Client Source: Sediment Sample

Sieve Size	Retained Fractional Weight	Retained Fractional Percent	Percents Cumulative Retained	Percents Cumulative Passivg	Spec.
3"					
1"					
314"					
`318"	0.0	0.0	0.0	100.0	
#4	1.3	0.3	0.3	99.7	
.#8	5.8	1.2	L5	98.5	
#10	3.2	0,7	2.2	97.8	
#16	34.5	7.2	9.4	90.6	
#30	196.3	41.0	50.4	49.6	
#40	122.1	25.5	75.9	24.1	
#50	85.5	17.9	93.8	6.2	
#100	28.5	6.0	99.8	0.2	
#200	0.4	0.1	99.9	0,1	<5.0
Pan	0.1	0.0	99.9		
LBW	0.4	0.1	100.0		
'TOTAL	478.1	100.0			

blialWidginufSaMPle	478.1 gm		
Weight After Washing	477.7 gm		
Loss By Vitiating (Clay & Sik)	0.4 gm	0.1%	
Antrim Modulus	-----.		
Crnsaed Material	---	gm	%
Organic Plate No.	—		
Clay-Ironstone	——	PI	%
Soft Partmeonciuding: 03 Clay-Trunstane	—	Sm	
(2)Clx.rt	---	gm	%
Snm of (1) -I- (2)	. —	gm	

REMARKS:

Material meets 1VLDEQ specifications for dredge material (greater than 95% retained on f/200 sieve)

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SIEVE ANALYSIS
ASTM 0422

Client Name: ALS e-Lab Analytical Services

Project Name: 0711546 Project No.: 0710167.4A

Date: 1213107 Technician: Dan Maxim

Soil Description: Fine to Medium. Sand, Trace Coarse Sand, Trace Organics (Shells)

Sample I.D.: PS-4 Sampled By: Client Source: Sediment Sample

Sieve Stm	Retained Fractional Weight	Retained Fractional Percent	Percentseuntulative Retained	Percentseuntulative Passing	Spec.
3"					
1"					
1/4"					
3/8'	0.0	0.0	0.0	100.0	
#4	0.3	0.1	0.1	99.9	
#8	12.8	2.7	2.8	97.2	
#10	6.6	1.4	4.2	95.8	
#16	44.6	9.4	13.6	86.4	
#30	132.5	28.0	41.6	58.4	
#40	991	20.9	62.5	37.5	
#50	135.1	28.4	90.9	9A	
#100	42.5	9.0	99.9	0.1	
#200	0.4	0.1	100.0	0.0	<5.D
Pan	0.0	0.0	100.0.		
LBW	0.0	0.0	100.0		
TOTAL	473.9	100.0			

biltionA'WdofSmnOs		473.9	gm
WeightAfter Washing		473.9	gm
Loss By Washing (Clay & Silt)		0.0 gm	0.0%
Fineness Modulus	—		
Crashed Material.	——	gal	
Organic Mate No.	—		
Clay-tamstaae	--..	gm	%
Safi Particles Indurling: (1) Clay-Ironstone	—	glo	%
(2) Chert	—	gm	
Sum of (1) + (2)	-— ·	gal	%

REMARKS

Material meets MDEQ specifications for dredge material (greater **than 95% retained** on #200 sieYe)

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SIEVE ANALYSIS
ASTM D422

Client Name: ALS e-Lab Analytical Services

Project Name: 0711546 Project No.: 0710167.4A

Date: 12/3/07 Technician: Dan Manor

Soil Description: • Medium to Coarse Sand, Some Fine Sarin, Little Organics (Shells)

Sample T.D.: PS-5 Sampled By: Client Source: Sediment Sample

Sieve Size	Retained Fractional Weight	Retained Fractional Percent	Percents Cumulative Re.rained	Percents Cumulative Passing	Spec,
3"					
1°					
3/4"					
. 3/8"	0.0	0.0	0.0	100.0	
#4	13.8	2.8	2.8	97.2	
#8	51.5	10.3	13.1	86.9	
#10	19.3	3.8	16.9	83.1	
#16	78.6	15.7	32.6	67.4	
#30	128.3	25.6	58.2	41.8	
#40	92.0	18.4	76.6	23.4	
#50	66.3	13.2	89.8	10.2	
#100	39.6	7.9	97.7	2.3	
#200-	4.7	0.9	98.6	1.4	<5..0
Pan	1.3	0.3	98.9		
LBW	5.4	1.1	100.0		
TOTAL	500.8	100.0			

Initial Weight of sun*	500.8	gm	
Weight After Washing	495.4	pm	
Loss By Washing (Clay & Silt)	5,4 gm	1.1%	
Fineness Modulus	---		
Crashed Material	--	gm	
Organic Plate No.	---		
Clay-Ironstone	—	gm	
Soft Particles Including: (1) Clay-Ironstont	--	gm	
C2) Chen	—	gm	
Sum of (1) ± (2)	–	gm	

REMARKS:

Material meets MDEQ speci&ations for dredge material (greater than 95% retained on #230 sieve)

with the hydraulics lab and became part of what is now called the Coastal and Hydraulics Laboratory.
Q. Under section 1-1-2, the Purpose of the CEM, the document provides there, that, "There exists a need for a single state-of-the-art technical document which incorporates the tools and procedures used to plan, design, construct and maintain coastal projects," is that correct?
A. Yes, sir.
Q. And then further on in that paragraph it says that, The purpose of the CEM project is to develop an engineering manual which includes the basic principles of coastal processes,' is that correct?
A. Yes.
Q. And the engineering manual also would include, the basic principles of "methods for computing coastal engineering planning and design parameters," is that correct?
A. Yes, sir.
Q. It also would include engineering principles for the "guidance on how to formulate and

chairman and possibly revise outlines, authors lists and the schedule going forward through you as the CEM manager to the CERC steering committee, is that correct?

A. Yes.

Q. It also states in terms of the secruence of events in subsection H that you as the part chairman would need to review the CEM structure, goals, development processes and the detailed outlines as the material was submitted, is that correct?

A. Yes, sir.

Q. Then under the sequencing, the author here is identified as preparing the first draft of the chapter and submitting it to the part chairman, is that correct?

A. Yes.

Q. And with respect to Chapter 5 of section 3 of the Coastal Engineering Manual, the lead author was Dr. Robert Nairn, is that correct?

A. Dr. Nairn, and also working with him was Mr. Willis, David Willis.

Q. Both of these people are outside of the

United States Corps of Engineers, is that correct?
A. Yes.
Q. And then under this sequence of events, after Dr. Nairn and Dr. Willis prepared the first draft, it was submitted to peer review for technical competence, is that correct?
A_ Yes.
Q. And then under the sequence, the first draft was to be revised, incorporating those comments resulting from the peer review, and submitting a second draft, is that correct?
A. Yes.
Q. Then eventually the second draft is revised again and submitted, and the draft part is submitted to the HQUSACE technical monitors. What and -- you are actually submitting it to the technical monitors, correct?
A. **Yes,**
Q. Ms. Pope, what is the HQUSACE?
A. That's the Headquarters Corps of Engineers.
Q. And who are the technical monitors --

A. Yes. That is actually true for unconsolidated shorelines as well.

Q. If Z now can direct your attention to page 9 of the Coastal Engineering Manual. And it states there toward the bottom in section C that the 'Sand can also provide a protective cover to the underlying cohesive substratum," is that correct?

A. Yes.

Q. The manual also states that, "However, only when the sand cover is sufficient to protect the cohesive substratum at all times will the shore revert to a sandy classification, i.e., truly a thick pile of sand, closed paren, period," is that correct?

A. Yes, sir.

Q. So if visually you see cohesive material exposed in the troughs and you see a receding bluff line, that would be an indication that the thick pile of sand no longer exists and is not protecting the cohesive substratum at all times, is that correct?

A. Yes.

Q. The next subsection D, it says, "On consolidated cohesive shores, the rate of lakebed or

seabed downcutting determines the long-term rate at which the bluff or cliff retreats at the shoreline," is that correct?

A. Yes.

Q. This is a description of essentially what has been called the Brune rule, are you familiar with the Brune rule?

A. I am.

Q. Could you describe for the Court what the Brune rule is?

A. It is effectively a rule of thumb that was developed by Pere Brune in probably the 1950s. It is a way of looking at sandy shores in the context of water level changes. And in short, it predicts that if the water level rises, the profile will be in disequilibrium and retreat to a new profile which is displaced landward associated with the increase in water level.

Q. Where --

A_ The converse, if it drops, the profile will mature to a point where it will have a similar profile, but displaced waterward.

conditions. And we find the photograph at -- the photographs at page 51.

In connection with the Coastal Engineering Manuals comments on appropriately designing shore protection, a figure 111-5-27 gives an example of "A toppled concrete seawall along the Lake Michigan coast of Berrien County. Failure probably resulted from undermining of the underlying glacial till foundation." And the date is April 1991.

Did I read that caption correctly, with respect to that figure?

A. You did_

O. And then below in figure 111-5-28, there is another photograph, and those are groins in the photograph extending vertically into the lake, is that correct?

A. Yes.

Q. The groin is designed to capture sand as it moves in one littoral direction or another, is that correct?

A. Primarily the intention is to trap sand that is moving in a dominant direction of the shore,

it

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either to the south or to the north.

Q. This caption for this photograph states, "A steel sheet-pile wall and groin field has been ineffective at protecting this section of cohesive shore along the Berrien County shore of Lake Michigan, south of the town of St. Joseph, April 1994,' is that correct?

A. That's correct.

Q. This was -- if I understood the Coastal Engineering Manual guidelines that you prepared, the authors were to select the photographs and prepare the graphs to be submitted in the chapter and subparts?

A. That's correct.

Q. So this would have been a photograph in all likelihood provided by Dr. Nairn?

A. He included it in this chapter. It is not indicated who actually took this photo.

Q. But it was -- but it was selected by the author as an example of failed shore protection along a cohesive shore in Berrien County in April of 1994, is that correct?

rebound and represent a lakewide average. It is clear from this figure that lake level has fluctuated within the modern range for at least the last 1,000 years and possibly for the last 2,000 to 3,000 years, and there has not been a long-term rising or lowering trend through this period. (Larsen; 1994 and Baedke and Thompson, 2000) indicate that the long-term stability of Lake Michigan water level is attributed to the stability of the primary outlet for Lakes Michigan-Huron through the St. Clair River, both in terms of the size and depth of the outlet, and glacial rebound (Larsen (1994) determined that the St. Clair River outlet stopped eroding 2,100 years ago, whereas Baedke and Thompson (2000) concluded that the outlet stopped eroding 3,500 years ago). Glacial rebound is a process whereby the earth's crust is adjusting (rising or lowering) in response to compression from the weight of the glacial ice mass. Figure 2.2 shows the latest estimate of differential glacial rebound in cm/century (LIC Coordinating Committee, 2003). The northern parts of Lake Huron (Georgian Bay) are rising at approximately 30 cm/century, whereas the southeast Lake Michigan shoreline is lowering at approximately 9 cm/century. Figure 2.2 also shows that the outlet to Lakes Michigan-Huron is relatively stable, partly explaining why lake level has had the same long-term average for the last 2,100 to 3,500 years (Larsen, 1994 and Baedke and Thompson, 2000). In summary, while the lake wide average levels for Lake Michigan have been relatively stable for at least the last 1,000 years, the landmass in the study area is slowly submerging due to differential glacial rebound (Le. at a rate of approximately 9 ern/century). This latter effect will give rise to erosion and retreat of the shoreline in the study area, independent of other natural and human influences.

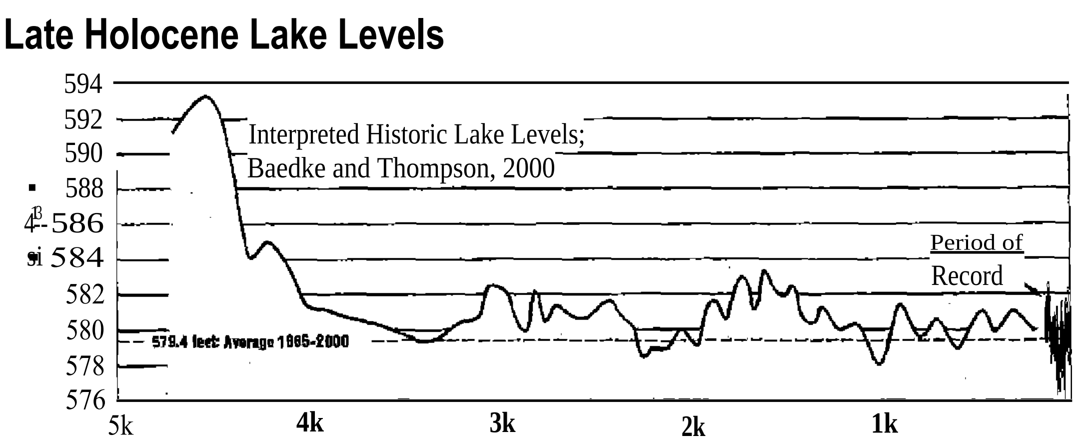

Figure 2.1 Holocene lake levels — Lake Michigan (from Baedke and Thompson, 2000)

The predicted average annual net longshore sand transport rate variation along the shore is shown in Figure 2.9. These rates were estimated using the nearshore profile (and slope steepness) that existed in the mid-1800's. In other words, they represent pre-harbor conditions. Moving south from South Haven there is a zone of reducing and converging longshore sand transport a condition that should correspond to a stable or accreting shoreline (since there is more sand entering than leaving this area). This zone is marked as Zone 'A' in Figure 2.9. This corresponds to a sandy area of the shoreline dominated by sand dunes that, from our analysis, appear to have been stable in the long term (i.e. since the earliest photos in 1938). Figure 2.4 suggests this was a former embayment (i.e. for the shoreline) and the depositional gradient would have been sufficient to develop a sandy shore. The existing depositional gradient explains why the area is not currently erosional. Although this area would experience erosion, particularly during periods of high lake levels, in the long term it has been stable or accretionary.

For the 10-mile (16-km) long section of shoreline north of St. Joseph, there is a trend of an increasing longshore sand transport rate moving from north to south in addition to divergent transport at the north end of this zone (see Zone 'B' in Figure 2.9). As noted above, this condition prevents sand from building up on the shore and results in a situation of a cohesive profile that is eroding in the long term. This is an important observation as it defines the zone of bluff and nearshore erosion that supplies sand to the St. Joseph Harbor area and further south. The predicted net longshore sand transport towards the south at a point 2 miles north of the harbor (north of the north fillet beach) is approximately 40,000 cy/yr (30,600 m^{3}lyr).

The total amount of sand and gravel eroded on an annual basis from the bluffs north of the harbor (in Zone '8' on Figure 2.9) was estimated using long-term bluff recession rates, determined from comparison of bluff lines of historic charts and air photos, and stratigraphic data of Larson (2006). The total sand made available to the littoral system by bluff and lakebed erosion was determined to be approximately 50,000 cy/yr (38,000 rn^3), and this corresponds well to the predicted longshore sand transport rate of about 40,000 cy/yr (30,600 m^3) in Figure 2.9.

One of the more recent claims related to this litigation have suggested that harbors other than St. Joseph may have contributed to erosion south of St. Joseph Harbor. Owing to the fact that there is a divergent node for sand transport located in the vicinity of the dunes south of South Haven, it may be concluded that there is no supply of sand from shorelines further to the north of this location. Therefore, any possible impact of harbors to the north would not influence the supply of sand to the south of St. Joseph Harbor. Furthermore, since the net longshore sand transport rate is from north to south, harbors to . the south and west of St. Joseph also would not influence the supply to the 10 mile (16 km) reach of shoreline south of St. Joseph.

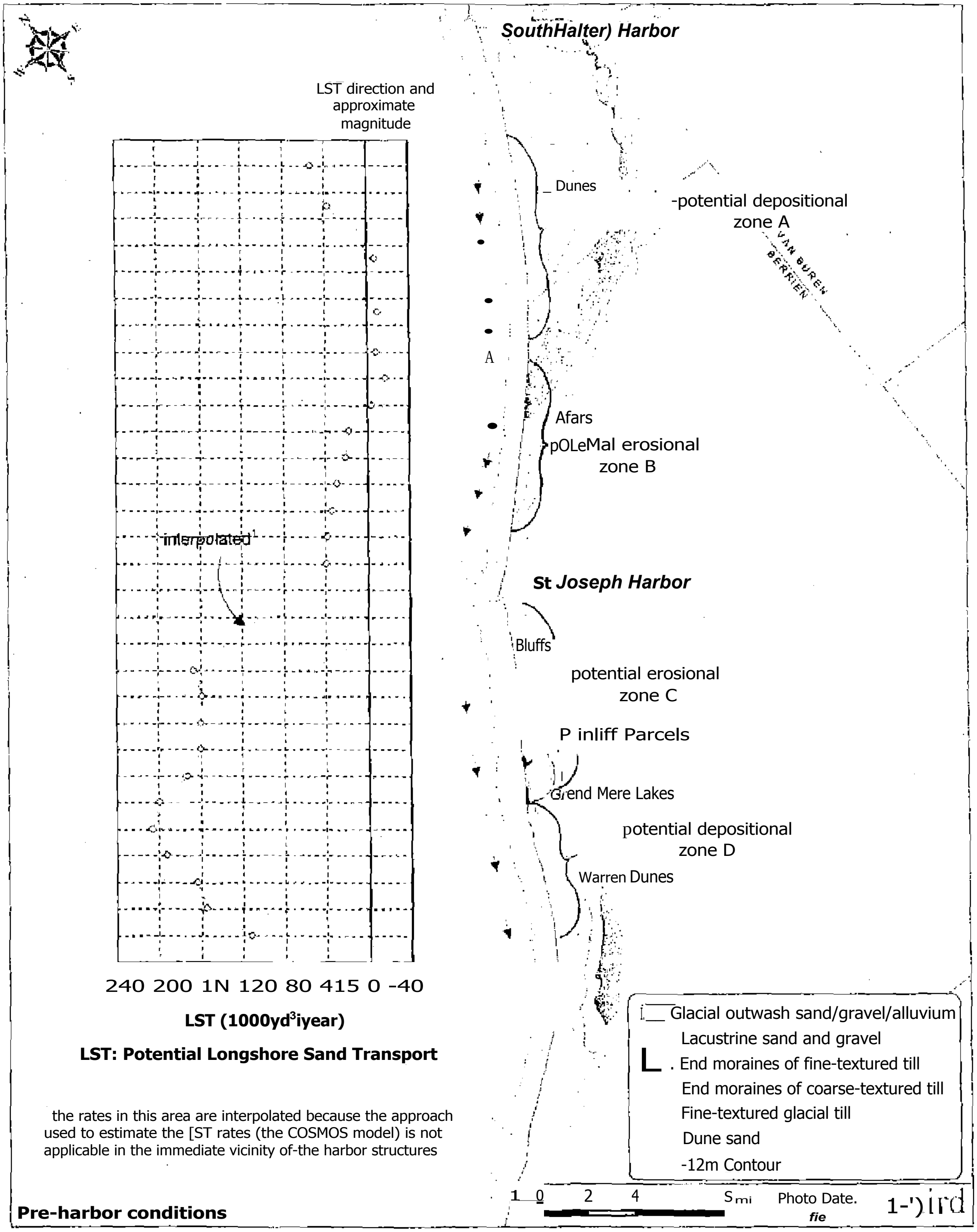

Figure 2.9 Predicted pre-harbor 'onshore transport rates in the study area
(pre-harbor nearshore profiles were used for the estimates)

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3.0 IMPACT OF THE HARBOR STRUCTURES, DREDGING, AND DAMS IN THE WATERSHED ON SUPPLY OF SAND TO DOWNDRIFT SHORES

The purpose of this section of the report is to evaluate the impact of human activities on the delivery of beach sand and gravel to the downdrift shores. These human activities fall into two general categories that are reviewed in Sections 3.1 and 3.2, respectively: 1) harbor-related influences, and 2) watershed changes. The integrated summary of the influence of the harbor and watershed changes on the total supply of sand past the harbor to downdrift shores is discussed in Section 4.

As explained in Section 2, the extent to which the harbor removes sand from the littoral system for a given period of time will determine the degree to which erosion downdrift of the harbor is increased above the natural background rate.

3.1 Harbor-related Influences

The three groups of possible sinks or losses of sediment that can be caused by the jetty, and related operations are discussed in this section_

Prior to construction of the harbor jetties, there was a spit extending southward across the river mouth (refer to the 1834 shoreline in Figure 3.5). At this time, any sand moving along the shore would have fully bypassed the river mouth and continued along to the south. In other words, there would have been no trapping of the annual net longshore transport rate of approximately 50,000 cy/yr (38,200 m^3/yr) to the south. The deficit between the supply rate of 50,000 ey/yr (38,200 ra^3/yr) and the outgoing transport rate of 205,000 cy/y (156,700 m^3) to the south end of the plaintiffs' properties defines the extent of erosion south of the harbor. How the harbor structures and the dredging related to harbor operations specifically influence this deficit will determine the net impact of the harbor for any given period. Throughout this report where we refer to "sand", unless otherwise stated, this is taken to mean the full range of sediment sizes found on beaches and the nearshore profile (generally from 0.125 mm to 0.7 mm — fine to coarse sand, and sometimes coarser).

The jetties at St. Joseph Harbor were initially constructed between 1837 and 1839. At that time the north structure was much longer than the south and extended approximately 8.53 chains (563 ft, 172 m,) into the lake from **the** original shoreline. There were several extensions to the north and south jetties starting in 1844. The final extensions to the present-day length were completed in 1903. The north jetty is approximately 2,740 ft long (835 m), but when measured perpendicular to the original shoreline, it represents an obstruction about 2,700 ft (823 m) long. The south jetty is about 175 ft (53 m) shorter than the north jetty. Figure 3.1 summarizes the history of St. Joseph harbor jetty extensions.

Figure 3.2 shows the situation after the initial completion of the harbor and demonstrates some of the key impacts of the harbor jetties in the first few years after they were constructed. Sand and gravel that would have otherwise moved past the original river mouth configuration is now trapped in the fillet (triangular shaped) beaches north and south of the north and south jetties, respectively. On the north fillet as sand is transported by northerly waves towards the south, some (and initially almost all) sand is trapped against the jetty, causing the fillet beach to grow rapidly. Once the fillet beach builds out, reducing the degree of sheltering, the southerly waves are eventually able to move the sediment out of the area back towards the north. Therefore, the north fillet beach would have grown at a rate at least equal to, if not more than, the net transport rate towards the south until such time that bypassing occurred. As a result, the rate of beach accumulation north of the north jetty may be used to estimate the net longshore sand transport rate (to the south for this location) for that period of time (considering that it may over-estimate the actual net rate due to the jetty sheltering effect on the ability of south waves to transport trapped sediment back to the north). With time, as the fillet beach approaches some form of equilibrium (i.e. the beach is filled to capacity relative to the length of the structure), the rate of accumulation reduces and eventually stops altogether (or becomes so small that it is not possible to quantify).

Sand is similarly lost into the south fillet beach; however, at this site much less sand has been trapped and removed from the littoral system through the development of the much smaller south fillet beach. The reason for the smaller south fillet beach is that the north waves, being larger, are able to remove much more sand from the south side of the south jetty (Dibajnia et al. 2004)

Comparison of pre-harbor and post-harbor charts (the latter soon after construction) also suggests that the south fillet was mostly formed by redistribution of the sediment that once formed the old river mouth bar prior to construction of the jetties. Therefore, contribution of littoral sediment to formation of the south fillet beach is considered small compared to that of the north fillet beach. In other words, the sand in the south fillet beach mostly does not represent a permanent loss to the downdrift shores.

In sediment budget terms, the north fillet beach represents a permanent sink for sediment, at least until it stops growing and reaches maturity in size and quantity.

As fillet beaches approach maturity in terms of growth, bypassing of the harbor commences, whereby sand moves around the harbor or in some cases may be stranded in deeper water. This process leads to three possible additional sinks for sediment. Sand transported along the shore by waves and wave-driven currents will attempt to reinstate the net rate of longshore transport by creating a bypassing shoal or bridge for sand transport. The bypassing shoal consists of sand that is deposited in deeper water, thereby creating shallower water conditions that are compatible with movement of sand around the harbor at a rate similar to the pre-existing and natural southerly net longshore sand transport rate. Therefore, this offshore deposition of sand results in a net loss to the littoral system (this sink is described in more detail in Section 3.1.3). As the bypass shoal builds, inevitably it disrupts the main purpose of the jetties — to create deep enough water for reliable navigation of vessels into and out of the river mouth — by providing the

pathway for sand to fill in the navigation channel. In turn, this results in the need to dredge. As the records show (see Section 3.1.2), this harbor has been dredged since at least the 1880's. Prior to the late 1960's the dredged sediment was dumped offshore and lost to the littoral system (i.e. another form of sink). If the dredged sediment is re-introduced to the littoral system through placement on downdrift beaches or in the nearshore zone, it is not lost from the littoral system, and no longer represents a sink.

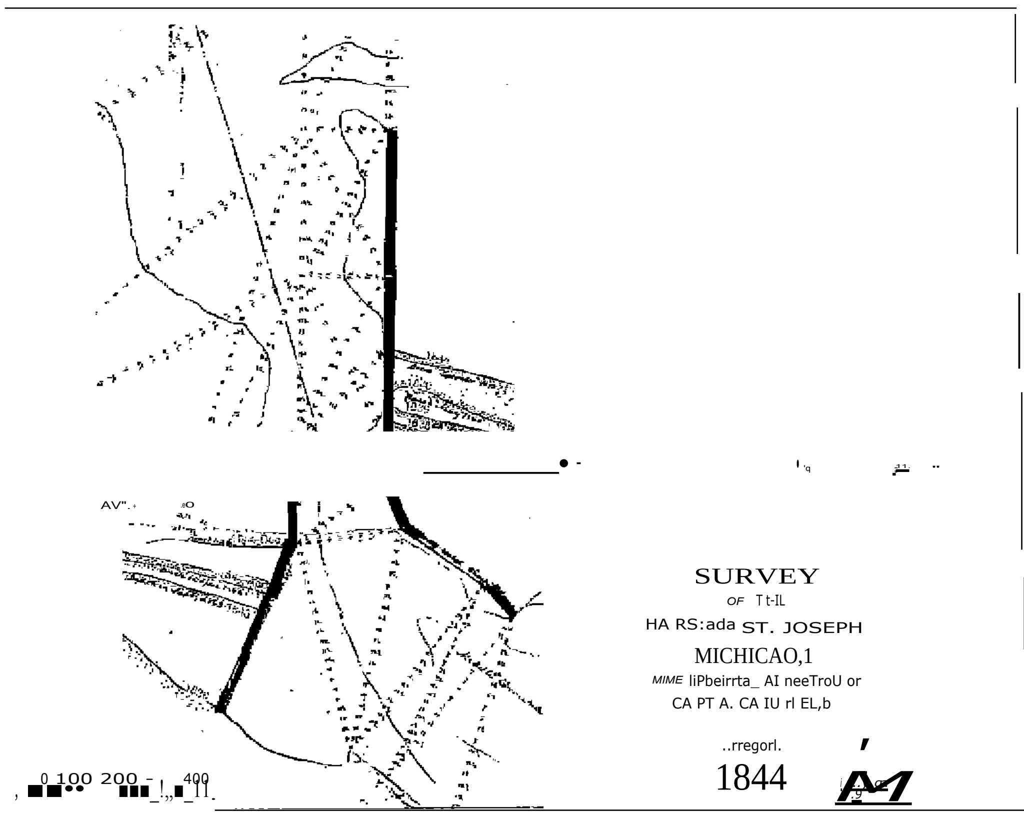

Figure 3.2 Fillet beach changes from 1836 to 1844

The final form of sink, which can occur at some harbors depending on local conditions, is the permanent offshore diversion of suspended sand through strong offshore-directed currents. These offshore-directed currents may be the result of a combination of wave-driven longshore currents deflected by the jetty and river flow currents focused by the jetties. One design philosophy behind jetties (and the source of the term "jetty") is to attempt to <u>**minimize**</u> dredging by concentrating the river flow to jet the sediment offshore.

In summary, the three key forms of sinks to the littoral sediment budget associated with harbors are:

1. Permanent accumulation of sediment in fillet beaches;

2. Dredging and offshore or upland disposal of sediment dredged from navigation channels;

3. Permanent loss of sediment to the creation of bypass shoals and the possible offshore jetting of sediment to depths where the sand/gravel does not return to shore through natural processes.

Each of these three possible sinks is evaluated in terms of the loss represented and the period over which the losses were experienced at St. Joseph Harbor. A summary Section 3_1A is presented, where the various approaches to estimating the net longshore sand transport rate to the south are compared to the results from Section 2.3

3.1.1 Sand Lost through Fillet Beach Accumulation

Accumulation rates north of the north jetty from the 1844 map (see Ehret Exhibit 72 reproduced as Figure 3.2) indicate an initial accumulation rate of 40,500 cy/yr (31,000 ru^3) between 1836 and 1844. This rate was estimated by multiplying the area of accumulation by a beach or profile height of 25 ft (7.5 **m}.** This profile height, extending from the average deepest depth of deposition to the average crest elevation of sand dunes, was determined from a review of nearshore profiles at the site dating back to an 1834 pre-harbor survey as shown in Figure 3.3. Due to the length of the north jetty, it is unlikely there was any bypassing during this period. While the south fillet beach (south of the south jetty) did expand during this period, it is our opinion that the growth resulted from two factors: 1) shoreward migration of the old river mouth bar that was bisected by the new jetties, and 2) the large offset distance between the tip of the north jetty and the root of the south fillet beach, by which any sand transported into this area could not be removed by waves from the north. Therefore, the 40,500 cy/yr (31,000 m^3/yr) would be a reasonable estimate of the net longshore sand transport rate to the south during the 8-year period from 1836 to 1844. If anything, 40,500 cyfyr (31,000 m^3/yr) would represent an overestimate of the net LST rate to the south because of, the inability of south waves to transport sand back towards the north once the sand was trapped in a sheltered zone against the north jetty, as explained in Section 3.1

The review of the rate of fillet beach infilling can be extended to include the many additional snapshots of the shoreline position through the 1800's and 1900's. Baird & Associates has obtained, reviewed and analyzed all of the available information including maps (with shorelines from 1830, 1834, 1836, 1837-1840, 1844, 1863, 1871, 1882, 1897, 1907, 1914, 1937, 1954, and 1979), and aerial photographs (1938, 1960, 1973, 1985, 1996, 2002 and 2003), bathymetry (1871, 1907, 1945, 1954, 1965, 1991, and 2001. All of the shorelines were converted to a common mapping coordinate system and are presented in Figures 3.4 and 3.5 for the north and south fillet beach, respectively. No attempt was made to correct the shorelines to adjust them to a common lake level.

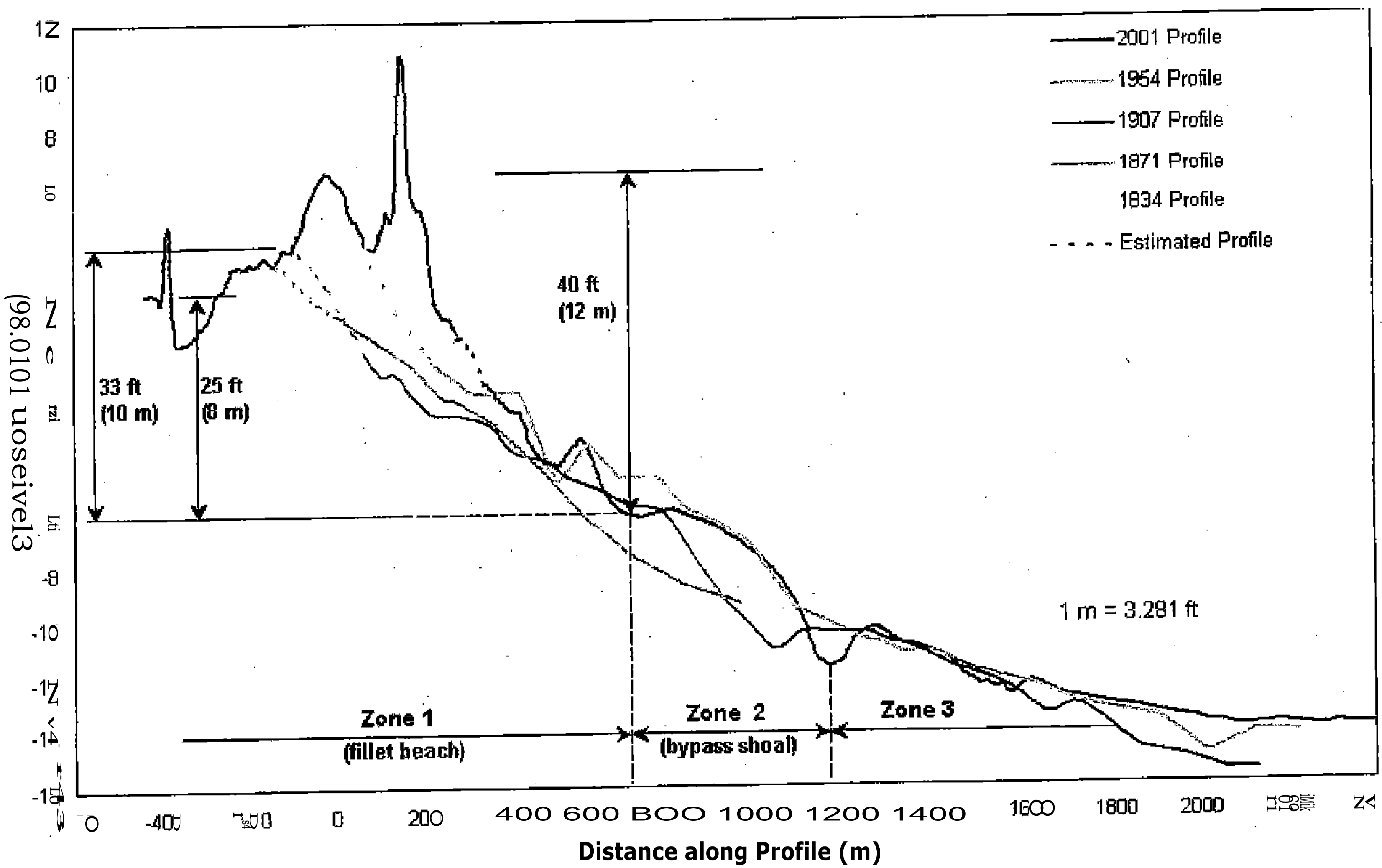

Figure 3.3 Profile height defmitions

Figures 3.4 and 3.5 show the historic shorelines and development of north and south fillet beaches, respectively, since 1834. It is important to note (as it influences the estimate of net southerly LST) that interpreting the volume of fillet beach growth from shoreline change figures alone is not straightforward for the following reasons: 1) the closure or toe depth of the beach can change through time, 2) the dune height may change through time, 3) the position of the shoreline on the profile changes with changing water level; and, 4) the profile shape changes with differing water level (i.e. profiles are steeper and beaches appear wider during low lake levels even though there has been no net volume change).

For example, the increase in fillet beach width between 1996 and 2002 is partly explained by the recent low lake levels and a steepening of the nearshore profile (i.e. with onshore transport of sand from directly offshore), but does not mean the fillet beach volume has grown through additional trapping.

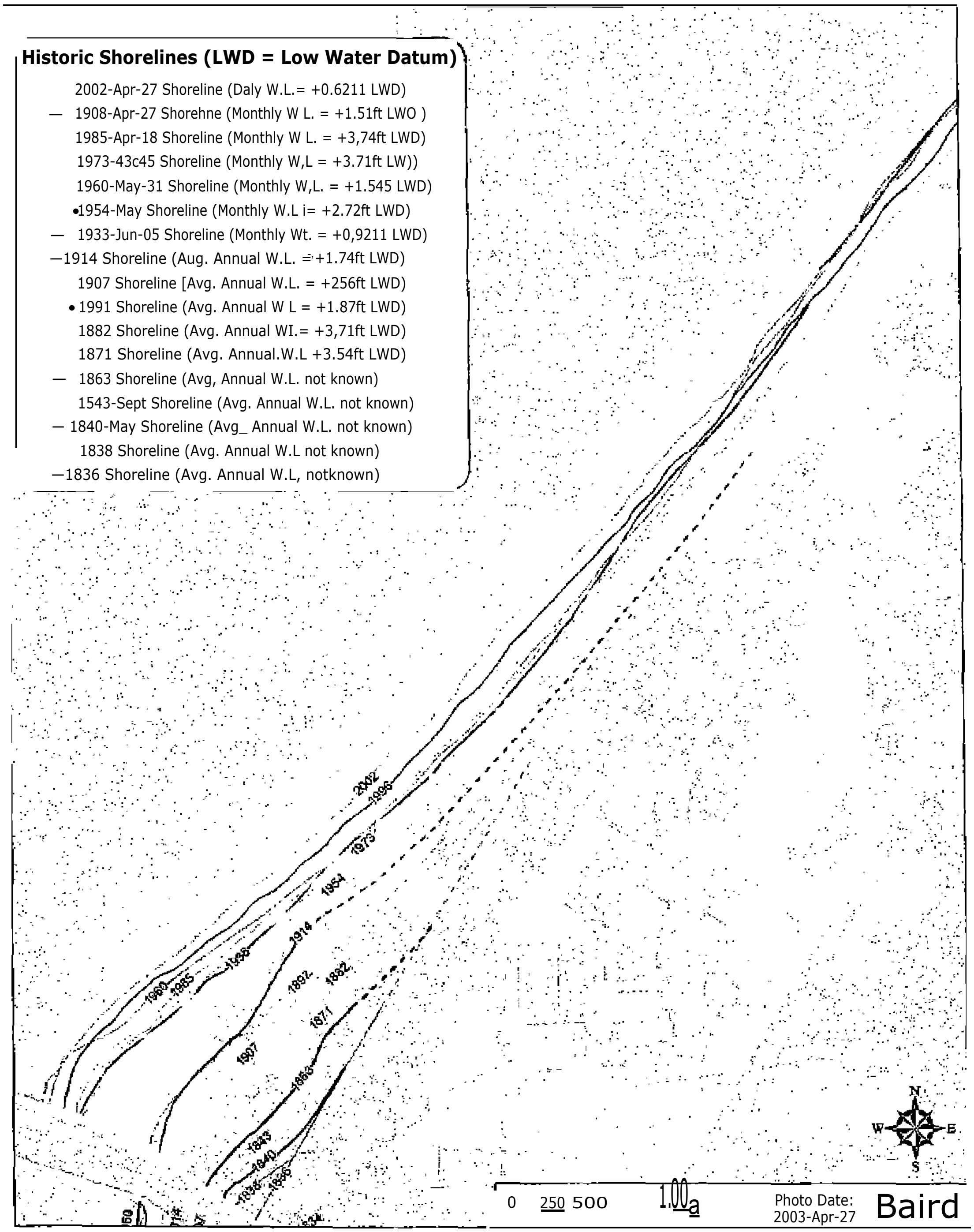

Figure 3.4 North Fillet Beach Shoreline Change

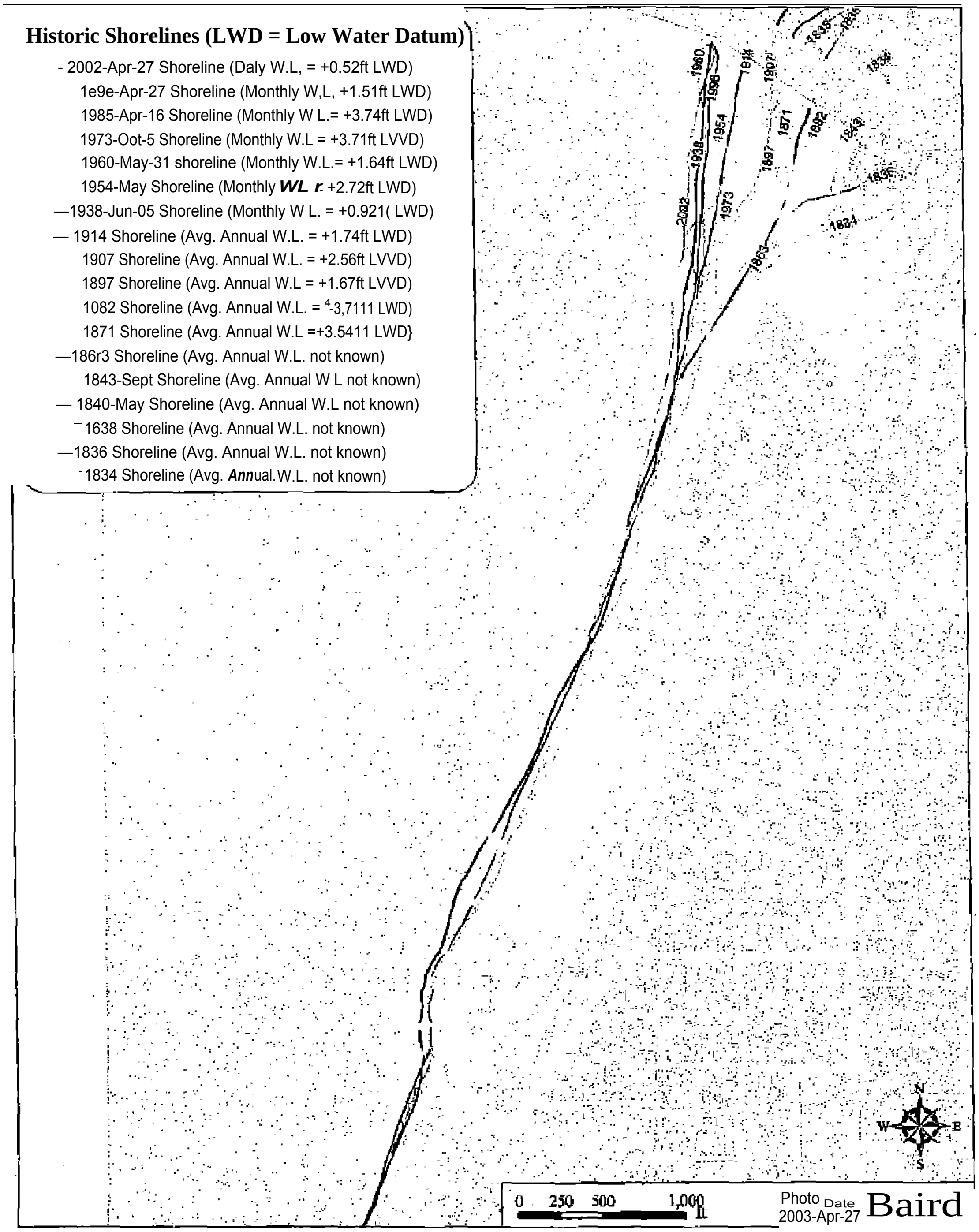

Figure 3.5 South Fillet Beach Shoreline Change

The history of the growth of the north and south fillet beaches are shown in Figures 3.6 and 17, respectively. These figures demonstrate that the variability in fillet beach size is related to natural factors (changing water levels, changing beach profile shape in response to lake level changes and storms and variable longshore transport rates from year to year). In particular, as the water level falls, more beach area is exposed. Therefore, to consider the true growth of the fillet beach, in terms of trapping, it is necessary to remove the variable water level effect. The solid lines represent an estimate of fillet beach area growth with the water level effect removed, The water level effect was removed by adjusting the fillet beach area by adding or subtracting area based on the difference between the water level at the time of the survey and a common reference level. The lines represent two different beach/nearshore slopes required for the adjustment and these two slopes represent the range of average beach slopes at the site derived from the available recent and historic nearshore profiles (see Figure 3.3, for example). The north fillet beach <u>has</u> three periods of response:

1) Between 1836 when the jetties were first constructed and around 1870 when they were first extended,

2) Between 1870 and 1893 to 1903, when the last lengthening of the jetties was completed in a series of stepwise extensions as shown in Figure 3.1, and

3) The period from 1903 to the present.

The three periods feature an asymptotic trend that is consistent with rapid initial growth followed by increasingly slower growth toward the end of each period (i.e. as more sand moves past the fillet beach into the navigation channel). In particular, the north fillet beach has had a slow growth over the last 30 to 40 years. Therefore, once the influence of water level variability is removed, it is evident that the fillet beach area is no longer expanding.

The pattern of the south fillet beach growth trend is shown in Figure 3.7. The St_ Joseph south fillet beach grew between 1836 (first construction of jetties) and 1938. However, since 1938 the south fillet beach has been relatively stable, This behavior suggests two explanations: 1) the net transport is towards the south (because the south fillet beach achieved its full capacity before the north fillet beach did); and 2) that north waves (and the current they generate) are now able to remove any sediment deposited on the south fillet beach by south waves.

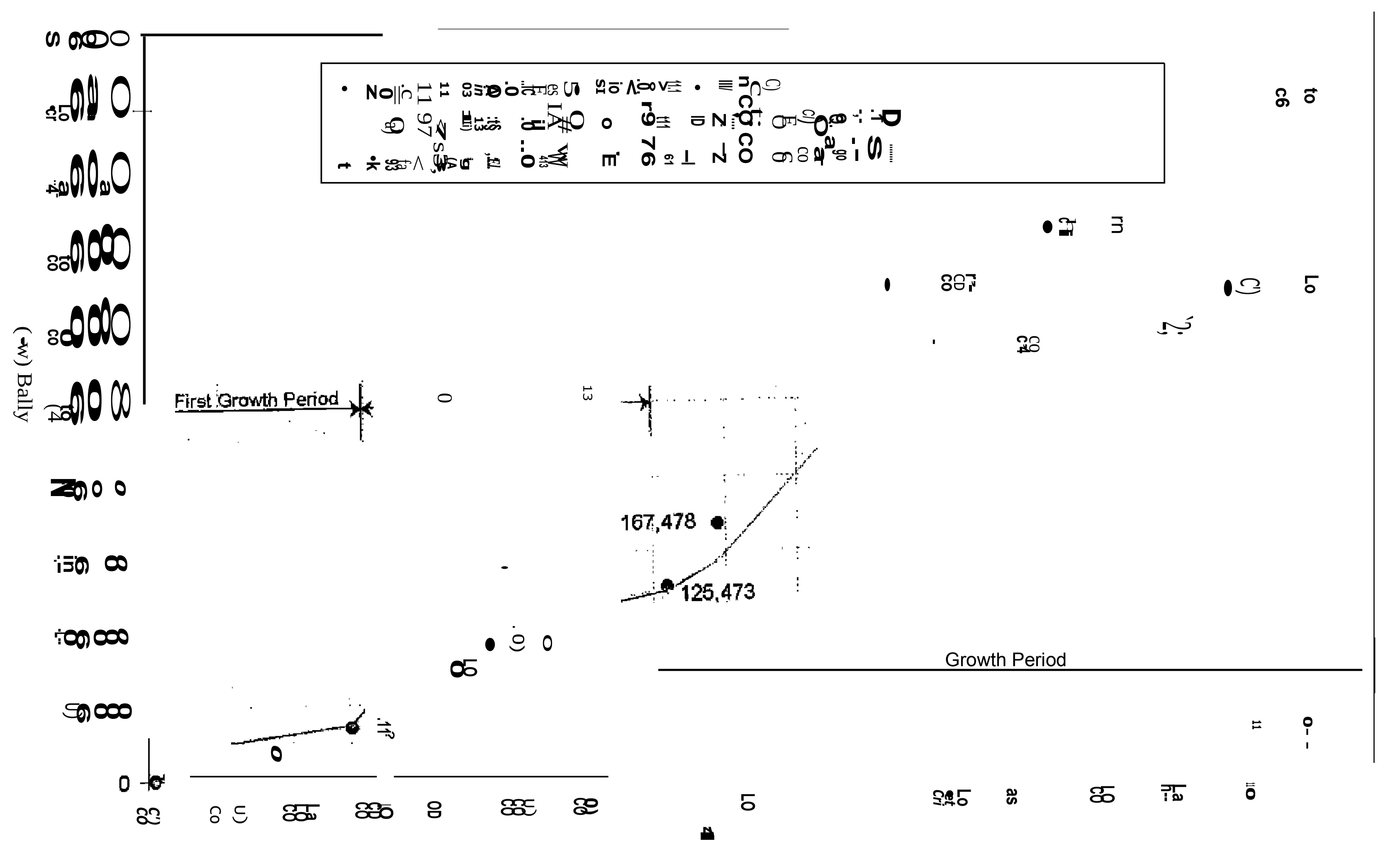

Figure 3.6 North Fillet Beach Growth

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and 3.17. The *HYDROSED* results for wave action only include part (a) and (b) figures showing the current velocity and sediment transport predictions, respectively.

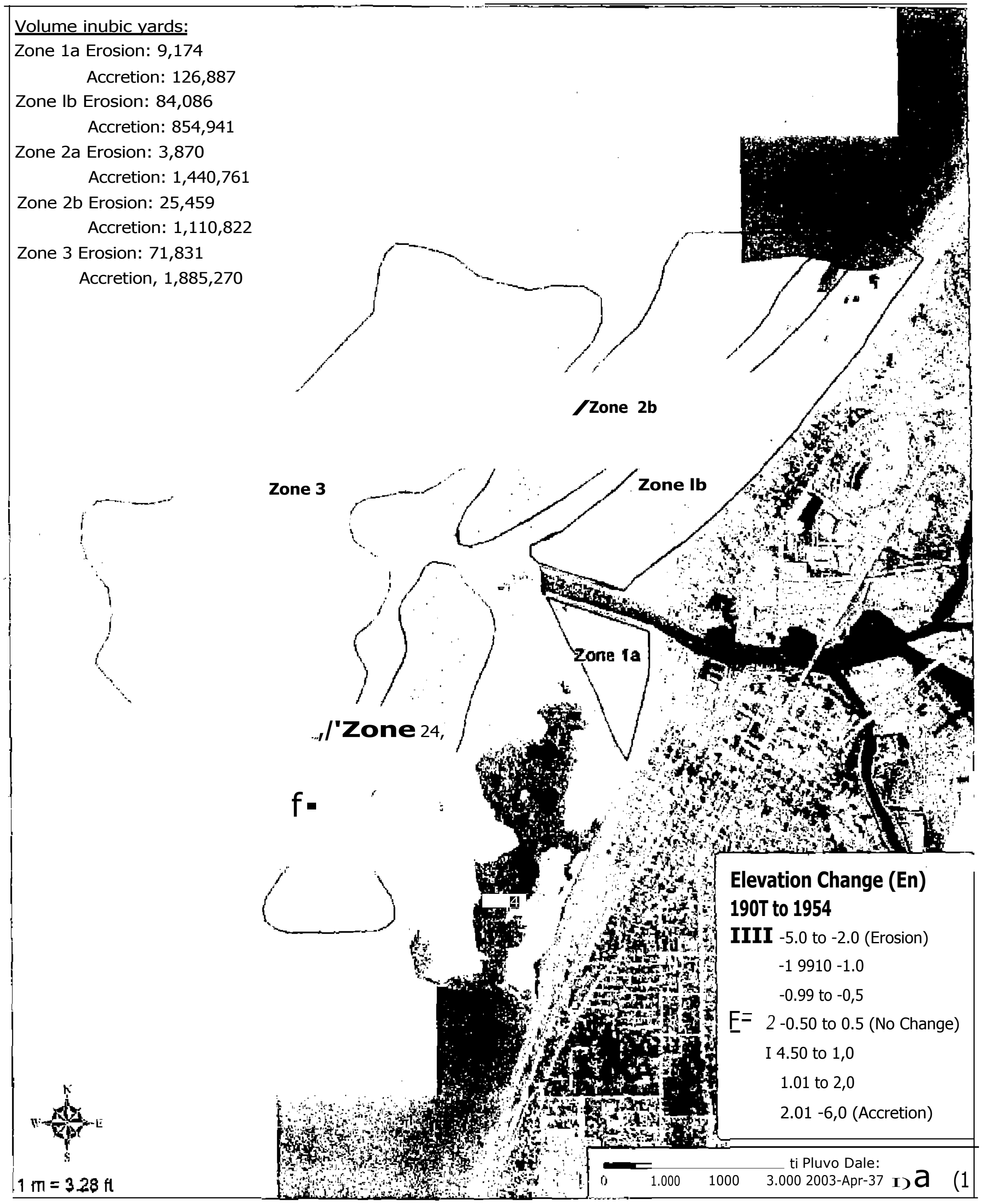

Figure 3.9 Lakebed change between 1907 and 1954

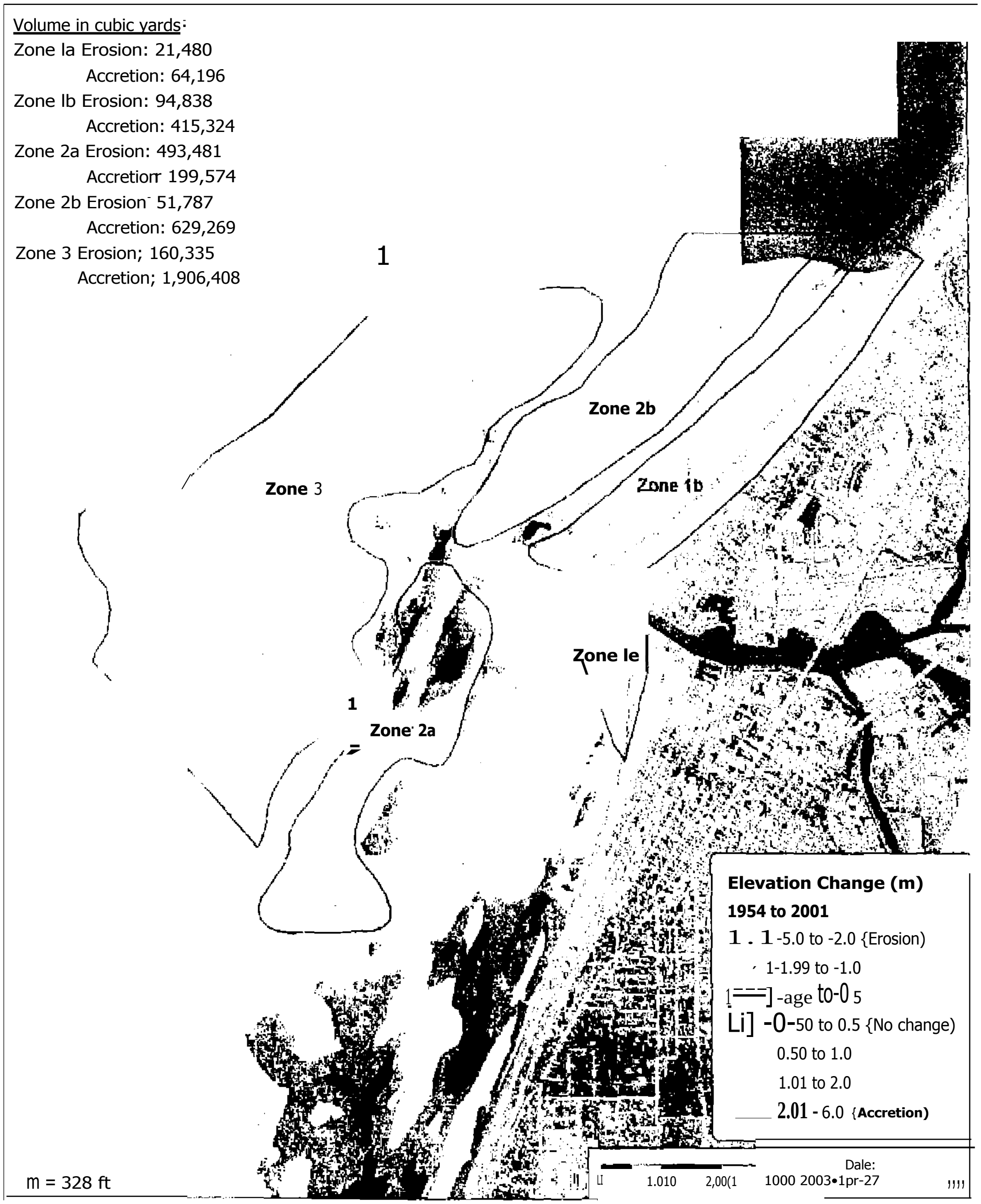

Figure 3.10 Lakebed change between 1954 and 2001

Referring to Figures 3,9 and 3.10, the deposition rate in Zone 3, was approximately 39,000 cy/yr (29,800 m^3/yr) (including both clay/silt and sand fractions) prior to 1954 and 37,000 cy/yr (28,200 m^3/yr) between 1954 and 2001, and 109,000 cy/yr (83,300 m^3/yr) up to 1970 (considering that offshore dumping was stopped in 1970). Based on the numerical modeling results, presented later in this section, and location data of offshore dumping (there were two sites approximately 1 mile offshore aligned with the north and south jetties), it appears that most, if not all, of the deposition in Zone 3 must have been a result of offshore dumping. The numerical model results, presented later in this section, demonstrate that even during very large river flows the pattern of sedimentation does not correspond to the observed pattern of deposition in the Zone 3 area Video and grain size analyses of part of Zone 3 completed by the USACE in 1997 (personal communication, Jim Selegean, USACE) indicates that the surface sediment size is consistent with river sand (D50 of 0.2 to 0.3 mm) and the existence of ripples at these depths supports the possibility that the discrete dump sites could have coalesced into the Zone 3 form.

The volume of sediment accumulation in Zone 2 corresponds to annualized deposition rates of approximately 65,000 and 3,900 cy/yr (49,700 and 3,000 m^3/yr) of sand for the periods 1907-1954 and 1954-2001, respectively. Since approximately 1970, there has been some minor erosion of the Zone 2a deposits, and accumulation has recently occurred in Zone 2b only, which indicates that part of the updrift supply is also deposited in Zone 2b (i.e. between the 6 and 11 m contours below low water datum). The numerical model results shown in Figures 3.11 to 3.13 demonstrate that when south and north waves interact with river flows, sediment is carried and, in some instances deposited in the two Zone 2 lobes. One reason for the reduction in the growth of the Zone 2 shoals is the increase in the navigation channel depth over the 1900's (see Figure 3.8 for the change in channel depth and Section 3.4.2 for the numerical model simulation of the influence of channel depth change). Also, it should be considered that the Zone 2 lobes effectively represent a bypass shoal for river sediment to make its way back to the shore (as shown in the model results presented in this section). It took many years for the bypass shoals to build and now they have effectively reached maturity (i.e, a similar asymptotic growth pattern to the fillet beaches). The Zone 2 shoals likely consist of a mix of sandy and silty sediments owing to important role of river sediments in building these deposits.

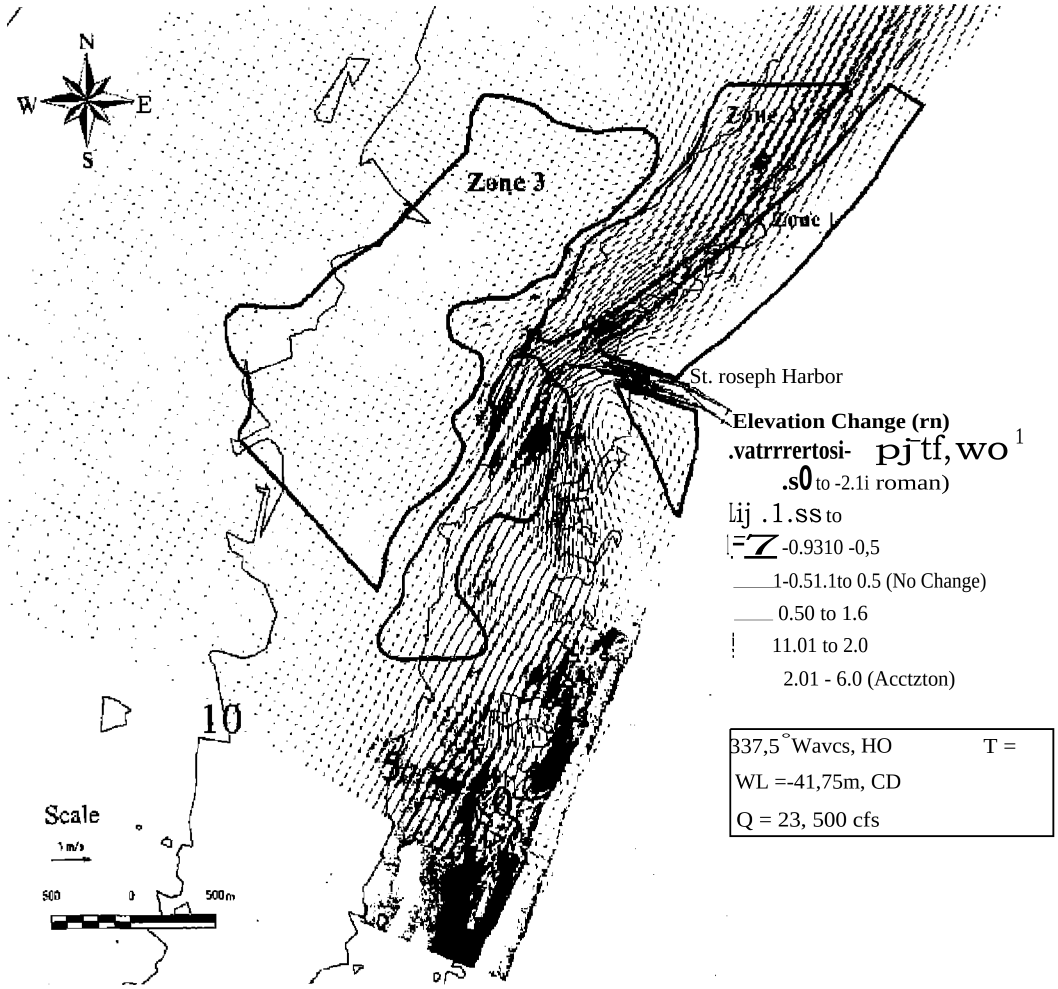

Figure 3.11 Nearshore currents (NW storm) with high river flow on 1907-1954 lakebed change *(HYDROSED)*

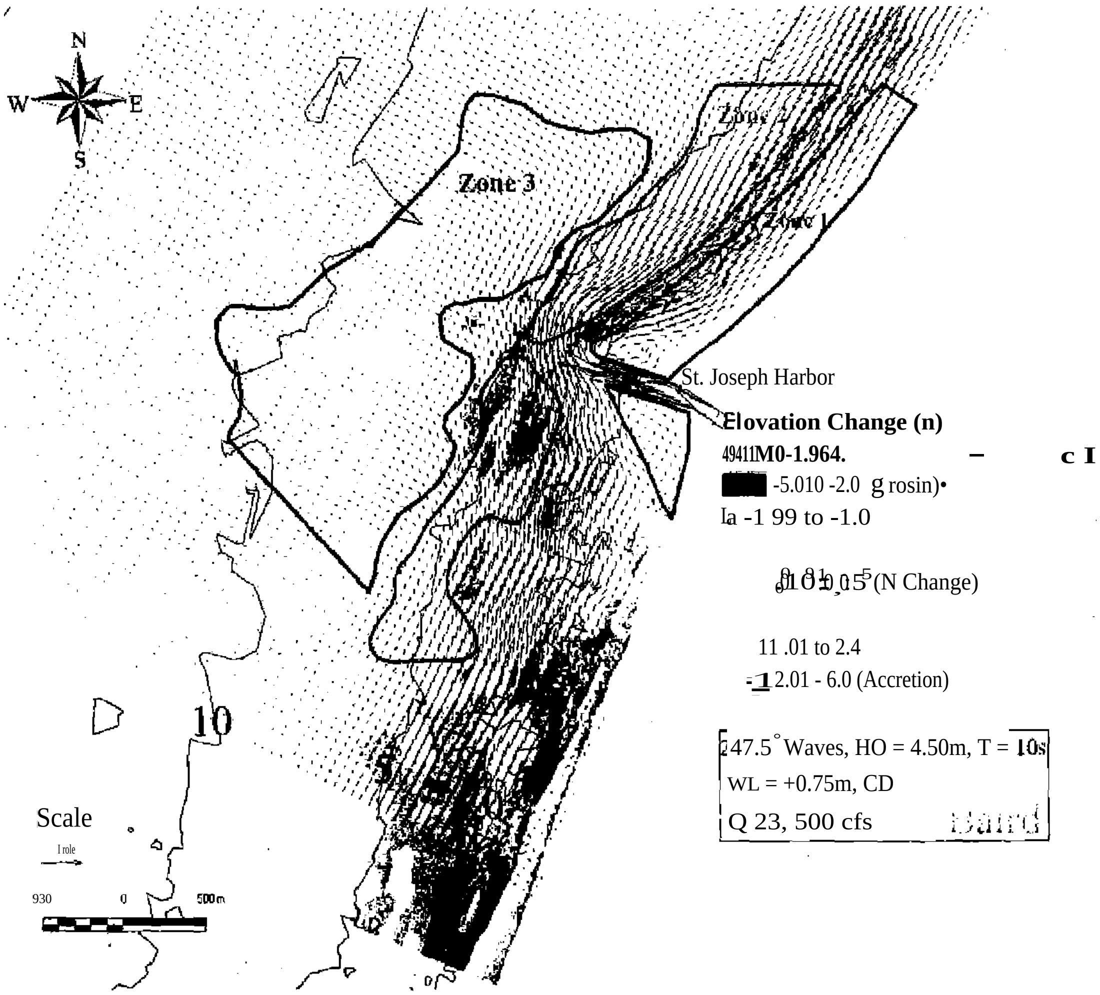

Figure 3.12 Nearshore currents (SW storm) with high river flow on 1907-1954 lakebed change *(HYDR 0 SE D)*

Table 4.2 Bluff Erogion Rates

Bluff erosion rates in ft/yr

	North of the harbor	**Reach 1**	**Reach 2**	**Reach 3**
1830 to 1871	0.75 (0.52)	5.25 (233)*	1.74 (0.92)	L08 (0.59)
1871 to 1938	131 (0.49)	1.48 (0.52)	2.33 (0.52)	1.74 (0.69)
1938 to 1960	0.92 (0.75)	1.12 (0.72)	1.94 (1.18)	0.85 (0.56)
1960 to 2002	0.75 (0.05)	0.75 (0.79)	2.7 (1.51)	1.15 (0.66)

* Values inside the parentheses show the standard deviation associated with the spatial averaging of the estimates of recession rate made every 20m within each reach_

Bluff **erosion rates in rn/yr**

	North of the **harbor**	**Reach 1**	**Reach 2**	**Reach 3**
1830 to 1871	0.23 (0.16)	1.60 (0.71)*	0.53 (0.28)	0.33 (0.18)
1871 to 1938	0.40 (0.15)	0.45 (0.16)	0.71 (0.16)	0.53 (121)
1938 to 1960	0.28 (0.23)	0.34 (0:22)	0.59 (0.36)	0.26 (0.17)
1960 to 2002	**0.23** (0.02)	0.23 (0.24)	0.82 (0.46)	0.35 (0.20)

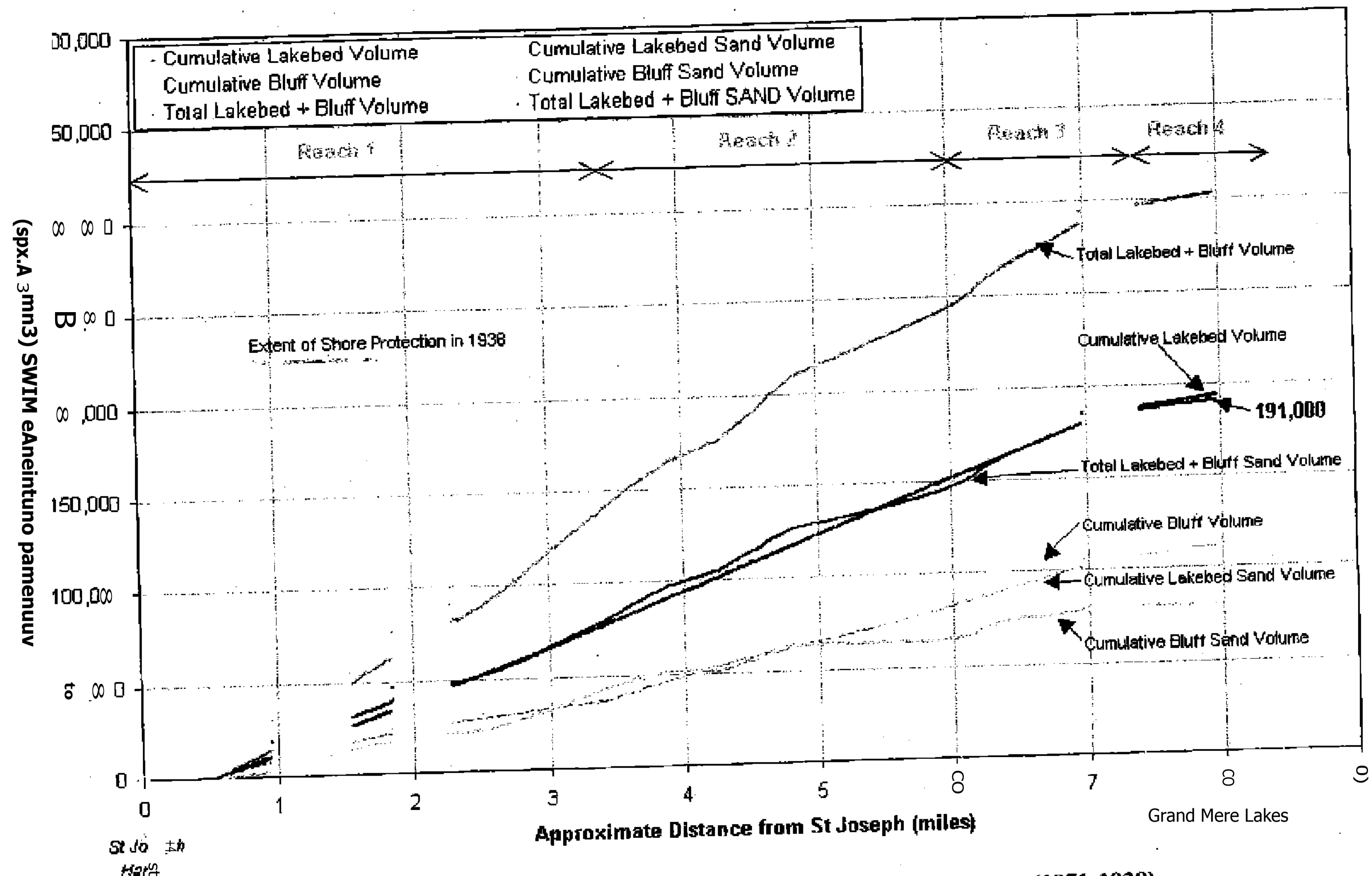

Figure 4.12 Annualized Cumulative Lakebed and Bluff Erosion Volumes (1871-1938)

Wave Height Rose
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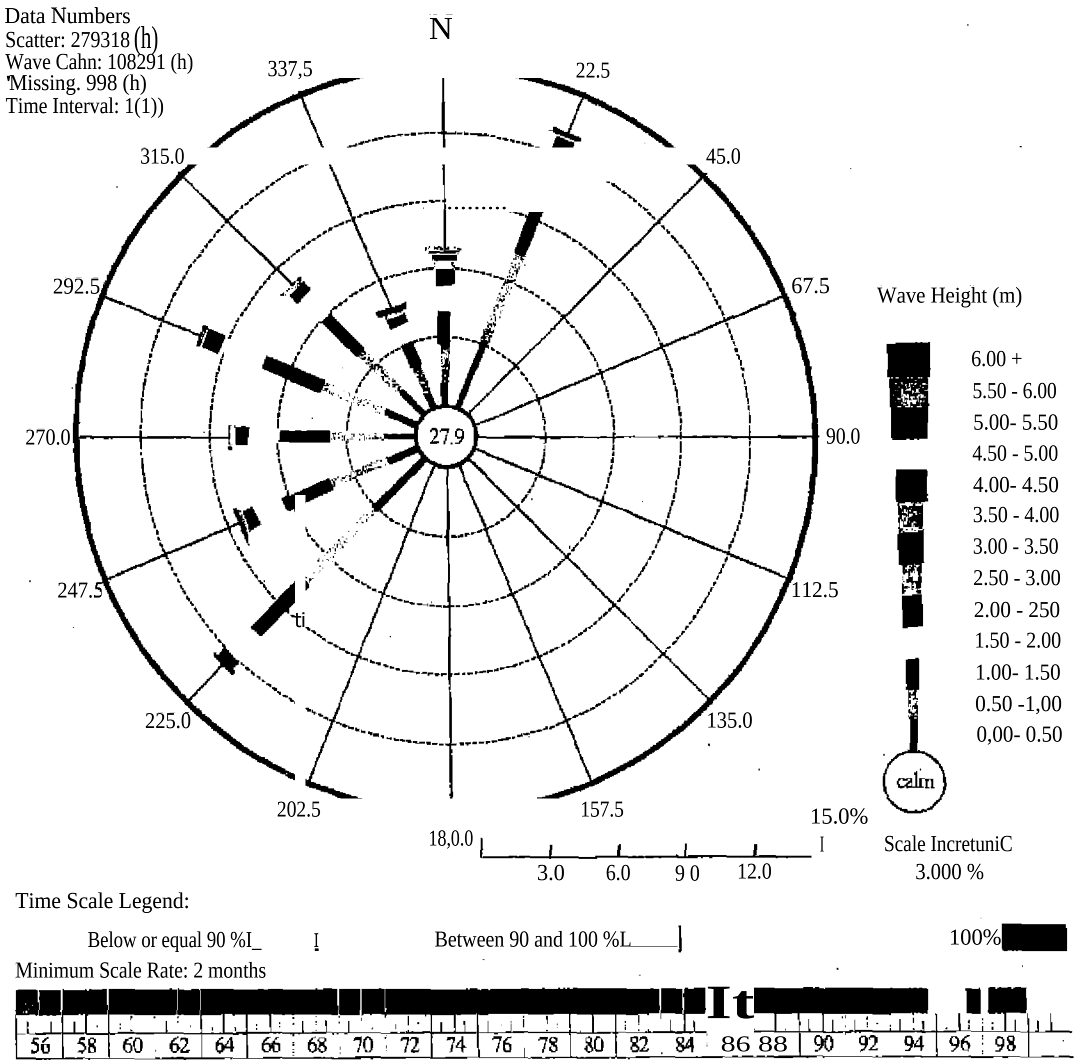

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Water Lewis: No water level data

Shore Ice: No shore ice data

Figure A20. Offshore Wave Rose

4.6 Sediment Budget for the Area South of the Harbor

4.6.1 Explanation of the Approach

In order to understand the changing impact of the harbor jetties and the navigation channel on the sand supplied to the shoreline south of the harbor (and the resulting influence on erosion processes), it is necessary to integrate the various changing factors through time that were investigated in Sections, 3.1 and 3.2. Table 4.4 summarizes the sediment budget from pre-harbor time to the present, considering the following sinks and sources: the river and updrift longshore sand supply, fillet beach growth, dredging, offshore losses, beach nourishment, bluff and lakebed erosion, dams, shore protection and outgoing longshore sand transport rate. It is important to understand that all of the entries in Table 4.4 have uncertainties associated with them; the numbers included in this table represent the best estimates based on the information available.

The sediment budget approach provides the most robust approach for understanding a complex erosion problem. This technique consists of quantitative balancing all supplies and losses (or inputs and outputs) with the net change to an area of interest. The strength of this approach is that there must be a balance in the final assessment. Inherently, as will be demonstrated, this approach provides opportunities for independent checks and balances of the individual inputs and outputs.

Seven periods from pre-harbor to present were considered. For each period the various components of the sediment budget were estimated (and checked to the extent possible) through various means. All of the values presented in Table 4.4 relate to beach sand-sized sediment (i.e. sediment too fine to remain on the beaches has not been considered) except values in Columns vii, ix(a, b) and x, which represent apparent (total fines and sand) volumes of capital dredging and accumulation volumes in Zones 2a and 3. The first column (Column i) in Table 4.4 shows the supply from updrift shore erosion that was considered equal to 50,000 cy/yr (38,228 m^3/yr) and unchanged through time (see Section 3.1.4). Columns ii(a) and ii(b) represent the north and south fillet infilling rates, respectively, which were determined from volume calculations based on shoreline comparisons shown in Figure 3.4 (see Section 3.1.1). Column iii shows total river sand supply to the harbor determined based on SWAT modeling (see Table 3.2 in Section 32.2). Column iv shows the portion of river sand that reaches the lake based on RMA2ISED2D modeling results (see Table 3.5 and Section 3.2.3). Column v shows the portion of updrift supply that passes by the north jetty into the navigation channel and downdrift determined from *TIYDROSED* modeling results (see Section 3.1.3). The next column (Column vi) gives the dredging volumes (see Figure 3.8 and Section 3.1.2). For each period, information on the inner and outer channel dredging is presented, based on the available information dating back to 1879 and estimated for the earlier periods from our understanding of the processes and model results.

For some periods in the 1900s it was necessary to examine the total inner and outer harbor dredging estimates by matching the accumulation volumes in Zone 3 as the dredged sediment was once dumped in this zone. The total average annual capital dredging (fines and sand) volumes are given in Column vii (also from Section 3.1.2). Average annual volumes of beach nourishment for the two most recent periods are shown in Column viii (see Section 3.1.6 and Figure 3.21). The deposition in Zone 2a and 2b offshore of the fillet beaches and harbor are given in Columns ix(a),and ix(b) respectively, and Zone 3 deposition is shown in Column x (see Section 3.1.3 and Figures 3.9 and 3.10).

Column xi gives the total sand delivered to the nearshore system downdrift (south) of the harbor. The total sand delivered to the downdrift shores is calculated as the sum of: river sand reaching the lake (Column iv), the updrift supply bypassing into the outer channel and downdrift (Column v), the outer channel dredging — a negative number since it represents a loss (Column vi(a)), beach nourishment (Column viii) plus half of the values (half, because this represents the approximate fraction of sand in these deposits) in Columns ix(a and b) which represent gain/loss to Zones 2a and 2b, respectively. The estimated average annual quantity of erosion (both bluff and lakebed, sand fraction only), for each of the periods and for the reach of shoreline extending from south of the south fillet beach limit to the southerly limit of the Plaintiffs' properties, is provided in Column iii. This quantity is estimated from the from the bluff and lakebed erosion volumes derived from the shoreline change and lakebed surface change analyses, respectively (see Sections 4.2 and 4.3, respectively). Average annual erosion volumes determined in Section 4.33 for four periods of pre-1836, 1871 to 1938, 1938 to 1960, and 1960 to 2002 were redistributed between the seven periods through interpolation.

Estimated outgoing longshore sand transport (LST) rates at the south end of Plaintiffs' properties are given in Column xiii. These values were determined in Section 4.5 and include the influence of increasing nearshore profile steepness (i.e. increasing the LST rates) through time.

The expected total lakebed and bluff erosion volumes south of the harbor are presented in Column xiv. This quantity is equal to the difference between the predicted outgoing LST rate (Column xiii) and the total sand delivered to the downdrift shore given in Column xi (i.e. the difference between the predicted incoming and outgoing sand quantities to the area of interest). This is an independent estimate of value presented in Column xii.

Column xv shows volume of sand trapped upstream of the dams on an average annual basis. The percentage of shoreline protected through the study area (8 4 miles) south of the harbor was determined from the air photos and is shown in Column xvi. Average nearshore bottom slopes determined from 1871, 1%5, and 1999 lakebed surveys are given in the next column (Column xvii), and these show that the bottom slope has increased as more shoreline is protected. This process of shoreline steepening and the resulting increase in longshore sand transport rates is explained in Sections 4.4 and 4.5 of the report.

The next series of three columns in Table 4.4 (Columns xviii, xix and xx) present "what if scenarios demonstrating the role of shore protection and dams on the erosion rates south of the harbor. The erosion that would have occurred without the impact of shore protection is calculated in two different ways. In Column xviii the estimated total lakebed and bluff erosion from Column xii is reduced by the difference between the outgoing LST for the period of interest and the pre-1836 LST rate of 205,000 cy/y (156,700 m^3lyr). In the second last Column xix the erosion without the shore protection influence is estimated using the difference between the total sand delivered to the downdrift shores (Column xi) and the pre-1836 outgoing LST rate of 205,000 cy/y (156,700 m^3/yr). The expected shore erosion in the absence of dams and shore protection is calculated by adding Columns xix and half of the value in xv and the result is presented in Colornn xx. The erosion was reduced by half of the total sediment trapped upstream of dams because it was assumed that only have of the sand would have reached the lake due to inner harbor dredging efforts.

The final pair of Columns xxi(a) and xxi(b) present the estimated impact of the harbor and its operations (i.e. including fillet beach and bypass shoal trapping, dredging, offshore disposal before 1970 and mitigation through beach nourishment after 1970) on downdrift erosion using two approaches. In other words, these columns present estimates of the increase or decreased in erosion over the background rate, solely related to the harbor impact. The two approaches are based on taking the differences between pre-harbor erosion rate and the two different ways of estimating erosion without the effect of shore protection for each time period as given in Columns xviii and xix. The differences between each pair of estimates in these two final columns give some indication of the degree of uncertainty in estimating the harbor impact. It is also noted that the actual erosion impact would vary significantly along the shore and this simply provides an overall estimate of erosion impact from south of the south jetty to the southerly end of the Plaintiffs' properties. In addition, it is noted that these are estimates for sand volume only as this has been the basis of this table and the techniques applied.

4.6.2 The Pre-Harbor Period

For the pre-harbor period, the total supply of sand. past the river mouth was estimated to be 64,000 cy/yr (48,900 m^3/yr) consisting of 50,000 cy/yr (38,200 m^3/yr) supplied from updrift and 14,000 cy/yr (10,700 m^3/yr) supplied by the river. The pre-harbor outgoing longshore sand transport rate at the south end of the study area was estimated to be 205,000 cy/yr (156,700 in^3/yr), based on numerical model results described in Section 2.3 (which were derived for the 1871 beach profile with a nearshore slope of 1/75, representative of the 10-mile (16 km) reach south of the harbor). The difference between 64,000 cy/yr (48,900 m^3/yr) entering and 205,000 cy/y (156,700 m^3/yr) leaving (i.e. 141,000 cy/yr (107,800 m^3/yr)) had to be compensated by the erosion of bluffs and lakebed. This volume is similar to the estimated average natural erosion rate of 1.75 ft/yr (0.5 m/yr) or 131,000 cylyr (100,000 m^3/yr) throughout the eroding area south of the harbor (Section 4.2.2 and Section 4.3.2 for derivation of the recession rate and erosion volume, respectively).

4.6.2 The Period 1836 to 1875

The period from 1836. to 1875 corresponds to the initial harbor configuration before the start of the jetty extensions. During this period, the north fillet beach could only trap a small portion of net southerly sand transport and most of the sediment could bypass the harbor because the jetties were short and the navigation channel was less than 16 ft (4.9 m) deep.

Volume estimates indicated an average fillet beach trapping rate of 21,000 cy/yr (16,100 m^3/yr) for this period. The quantity of sand supplied by the river also increased in this period because of the change in land use as explained in Section 3.2. There is no information on dredging activities in this period, however, based on RMA2 model results (Section 3.2.4) it is expected that the river flow (and the ship traffic) could keep the channel open without significant dredging requirements. Also, 75% of the river sediment load could reach the lake because of shallow inner harbor water (based on channel dredge records for the 1800's). It was therefore estimated that of the 33,000 cy/yr (25,200 m^3/yr) sand delivered by the river, 8,000 c_1/yr (6,100 m^3/yr) (25%) *was* deposited in the inner harbor and 25,000 cy/yr (19,100 m^i/yr) could reach the littoral system. Also, fillet beach volume estimates indicate that of the 50,000 cy/yr (38,200 m^3/yr) sand supplied from upchift, 21,000 cy/yr (16,100 in^3/yr) was trapped by the north fillet beach and thus 29,000 cy/yr (22,200 m^3/yr) bypassed the north jetty of which 5,000 cy/yr (3,800 m^3/yr) was deposited in the navigation channel and the remaining 24,000 cy/yr (18,300 m^3/yr) reached the downdrift shores. Approximately 8,000 cy/yr (6,100 m /yr) *was* trapped in the south fillet during this period.

In total, therefore, 41,000 cy/yr (31,300 ni^3/yr) of sand was delivered to the nearshore system. The outgoing LST rate at the south end of the study area would have remained the same as the pre-harbor value (i.e. 205,000 cy/y (156,700 m^3/yr)) and thus the deficit of 164,000 cy/yr (125,400 m^3/yr) of sand was eroded from the bluffs and the lakebed through the 10 mile (16 km) reach south of the harbor (this is slightly larger than its pre-harbor value). There is not enough bathymetry information from this period to directly confirm this number independently. However, based on simple interpolation between the earlier and later period it was estimated that the total erosion of bluff and lakebed was 161,000 cy/y (123,100 m^3/yr), which is similar to the sediment balance estimate providing *independent confirmation* of the approach.

The first dams on the St. Joseph River were constructed in this period.. It is estimated that on average these dams trapped 34,000 cy/yr (26,000 m^3/yr) of sand in this period. Therefore, if it were not for the darns, the bluff and lakebed erosion would have been - limited to 147,000 cy/yr (112,400 m^3/yr), which falls within the range of pre-harbor erosion estimates. There was no significant shore protection constructed in this period and therefOre there is no shore protection influence.

Column xxi(b) shows that the harbor impacts are estimated to result in an increase to erosion in the range of 30,000 cy/yr (22,900 m^3/yr) to 23,000 cy/yr (17,600 rn^3/yr) of sand:

4.6.3 The Period 1876 to 1903

The period from 1876 to 1903 covers harbor jetty extensions, which were completed by • . 1903. During this period, the north fillet beach trapping capacity increased gradually as the jetties were lengthened.

On average, volume estimates indicated that 50% of the supply of sand from updrift was trapped hi the north fillet beach during this period. Based on the data available, it is estimated that deposition in the navigation channel also increased to an average- of 9,000 cy/yr (6,900 na^3/yr). The river sand supply rate was estimated as 34,000 cylyr (26,000 m^3/yr). Again, it was estimated that 75% of the river sediment load could reach the lake because of shallow inner harbor depths (again based on the average annual • . dredging quantity of 24,500 cy/y for this period from Figure 4.8). It was, therefore, estimated that of the 34,000 cy/yr (26,000 m^3/yr) of sand delivered by the river, 8,000 cy/yr (6,100 m^3/yr) (25%) was deposited in the inner harbor, and 26,000 cy/yr (19,900 m^3/yr) could reach the littoral system. Also, of the 50,000 cy/yr (38,200 m^3/37r) of sand supply from updrift, 25,000 cy/yr (19,100 m^3/yr) was tapped by the north fillet and 25,000 cy/yr (19,100 m^3/yr) bypassed the north jetty of which 9,000 cy/yr (6,900 m^3/yr) was deposited in the navigation channel and the remaining 14,000 cy/yr or 10,700 m^3/yr reached the downdrift shores. Once again, approximately 8,000 cylyr (6,100 m^3/yr) was trapped in the south fillet during this period. The 8,000 cy/yr (6,100 m^3/yr) of river sand deposited in the inner harbor represents half of the actual • (sand + fine sediments) inner harbor sedimentation.

In total, therefore, 34,000 cy/yr (26,000 m^3/yr) of sand (26,000 cy/yr from the river, 25,000 cy/y of bypassing minus the 9,000 cy/y dredged from the outer channel and disposed of offshore, and minus 8,000 cy/yr lost to the south fillet), was delivered to the nearshore system. The outgoing LST at the south end of the study area would have remained the same at its pre-harbor value (i.e. 205,000 cy/y (156,700 m^3/34)), and thus the deficit of 171,000 cy/yr (130,700 m^3/yr) sand was eroded from the bluffs and the . lakebed over the 10-mile (16 kin) reach south of the harbor. The average annual sand volume eroded from the bbiffs and lakebed for the period of 1871 to 1938 was estimated _ in Section 4.3.2 to be 191,000 cy/yr (146,000 m^3/yr). Considering that this is a 68-year average value and that erosion should have been increasing with time, the value of 171,000 cy/yr (130,700 m^3/yr) (shown in Column xiv) would represent a reasonable estimate for the first half (1876 to 1903) of the 1871 to 1938 period, serving as *independent confirmation* of Column xiv estimated from the sediment budget approach. ,

Construction of dams on the St. Joseph River continued in this period: It is estimated that on average the dams trapped 69,000 cy/yr (52,800 m^{3}lyr) of sand. Therefore, if it were not for the dams, the bluff and lakebed erosion would have been limited to 129,000 cy/yr (98,600 m^{3}lyr), less than the pre-harbor erosion rate. There were no shore protection, effects in this period.

Columns xxi(a) and xxi(b) show that the harbor impacts are estimated to result in an increase to erosion of between 60,000 and 30,000 cy/yr (45,900 and 22,900 in^3/yr) of sand.

4.6.4 The Period 1904 to 1945

The period of 1904 to 1945 featured high trapping in the north and south fillet beaches due to the recent jetty extensions. The railway line south of the harbor was first protected in this period resulting in the introduction of significant shore protection to the downdrift shores.

As explained in Section 11.4, it is expected that the trapping rate of the north jetty. in this period was around 70,000 cy/yr (53,500 m^3/yr), i.e. higher than the net southerly transport and supply rates. This is because dining the early part of this period, when the jetties were long in relation to the size of the fillet beach, waves from the south would not have been- capable of eroding the north fillet beach, and therefore, the accumulation rate was larger than the net southerly transport rate. It is likely that little sediment was deposited in the navigation channel early in this period, again because of the significant lengthening of the jetties. The south fillet trapping started off high and tapered to almost nothing by the of the period for an average of 12,000 cy/yr (9,200 m^3/yr of sand), River sediment supply peaked in this period (50,000 cy/yr or 38,200 m^3/yr of sand), and it was estimated that 40% was deposited in the inner harbor because of increased inner harbor depths. The 40% trapping was based on the dredging records and is independently confirmed by the RMA2 model estimates of Section 32.4_ It was therefore estimated that of the 50,000 cy/yr (38,200 m^3/yr) of sand delivered by the river, 20,000 cy/yr (15,300 m^3/yr) was deposited in the inner harbor and 30,000 cy/yr (22,900 $m^{\prime}$/yr) reached the littoral system. Also, the north fillet beach trapped almost all of the sand supplied from updrift. The 20,000, cy/yr (15,300 na^3/yr) of river sand deposited in the inner harbor represents half of the actual (sand + fine sediments) inner harbor sedimentation. Considering that 40,000 cy/yr (30,600 m^3/yr) in total was deposited in the inner harbor, 3,000 cy/yr (2,300 m^3/yr) of deposition in the navigation channel results in a close match to the average dredged volume of 43,500 ey/yr (33,300 m^3lyr) shown in Figure 3.8 obtained from historic dredge records. Together with an average capital dredging total of 7,000 cyfyr (5,400 m^3/yr), the total dredged quantities amounted to 50,500 cy/yr (38,600 m^3/yr), which was dumped offshore. We compared the 1945 survey to the 1907 survey to obtain the vohime change in Zone 3. The results indicated an accretion rate of 61,000 cy/yr (46,900 m^3/yr) in Zone 3, which is within 20% of the above estimated dredging activities. The 30,000 cy/yr (22,900 m^3/yr) delivered by the river to the lake was mostly deposited in Zone 2 (based on numerical Modeling): An analysis of surface change in Zones 2a and 2b for this period. showed a total of 60,000 cy/yr (45,900 $m^{\mathbf{1}}$/yr) of sediment and 30,000 cyfy (22,900 m^3/yr) of sand deposition.

Therefore, no sand was delivered to downdrift shores in this period, in fact a negative supply or loss of 15,000 cy/yr (11,500 rn^3/yr) was estimated. The outgoing LST at the south end of the study area was estimated to increase to 224,000 cylyr or 171,250 m^3fyr

based on some initial steepening of the nearshore profile related to the fact that 10% of the shore was protected in this period (refer to Sections 4.4 and 4.5 for the procedure). Therefore, the 239,000 cy/y (182,700 m^3/yr) deficit between the incoming and outgoing sand transport to the 10 mile (16 km) reach south of the harbor would have been eroded from the bluffs and the lakebed. Redistributing the annualized eroded sand volumes of 191,000 cylyr (146,000 m^3/yr) and 209,000 cy/yr (159,800 m^3lyr) for the 1871 to 1938 and 1938 to. 1960 periods (estimated in Sec. 4.3.2), respectively, would result in an eroded sand volume of 194,000 cy/yr (148,300 ni^3/yr) for the 1904 to 1945 period. These two estimates of eroded volume south of the harbor are within 25% of each other_ Therefore, this is another *independent confirmation* of the sediment budget approach including the estimate of outgoing LST rate at the soutlyend of the Plaintiffs' properties. Two approaches to estimating the erosion that would have occurred in the absence of shore protection influences are presented in Columns xviii and xix based on adjustments to Columns xii and xiv, respectively. The estimates of 175,000 and 220,000 cy/y (133,800 and 168,200 m^3/yr) are less than the actual erosion but more than the pre-harbor erosion rate of between 131,000 and 141,000 cy/y (100,000 and 107,800 m^3/yr).

Danis trapped 102,000 cy/yr (78,000 m^3/yr) of sand in this period_ Therefore, if the impact of the dams and the shore protection are excluded, the bluff and lakebed erosion would have been limited to 169,000 cy/yr (129,200 m^3/yr), slightly greater than the estimated pre-harbor erosion rate.

Columns xxi(a) and xxi(b) show that the harbor impacts are estimated to result in an increase to erosion of 44,000 to 67,000 cy/yr (33,600 to 51,200 m^3/yr) of sand.

4.6.5 The Period 1946 to 1959

The period from 1946 to 1969 is the final period prior to the start of the USACE erosion mitigation measures. This period also corresponds to further deepening of the navigation channel and, therefore, more sediment deposition in the harbor area. Shore protection was constructed at many locations. Throughout the Great Lakes, the record high lake levels in 1952 resulted in the implementation of structures to prevent shoreline erosion.

The average trapping rate of the north fillet beach was estimated at 24,000 cy/yr (18,300 m^3/yr). The south fillet had reached full maturity by 1945 and was no longer trapping sand (see Figure 3.7). Dredging records indicate that the outer navigation channel dredging volume reached 30,000 cy/yr (22,900 m^3/yr) in this period, and has remained relatively constant since then. The average dredging rate from Figure 3.8 was 86,000 cy/yr (65,800 m^3/yr), which means that the inner harbor dredging was about 56,000 cy/yr (42,800 m^3/yr) of which 28,000 cy/yr (21,400 m^3/yr) (half) was estimated to be sand. River sediment supply was reduced to 41,000 cy/yr (31,300 m^3/yr) of sand in this period. If the inner harbor sedimentation is considered, only 13,000 cy/yr (10,000 m^3/yr) (32%) of river sand could reach the harbor entrance of which about 4,000 cyfyr (3100 pi^3/yr) was deposited in the navigation channel and only 9,000 cy/yr (6,900 m^3/yr) found its way to the littoral system. It is noted that the trapping rate.of 68% (100% - 32%) is greater than that 45 to 55% predicted by the RMA2 model and

summarized in Table 3.5 and this may be the result of generally lower flows through this period (see Figure 3.37, apart from one very high flow event in 1950, peak flows in this period were generally lower than earlier and later periods in the record). Considering that 56,000 cy/yr (42,800 m^3/yr) was the total deposition in the inner harbor and 30,000 cy/yr (22,900 m /yr) was deposited in the navigation channel, together with an average capital dredging of 4,000 cy/yr (3,100 m^3/yr) (from dredging records), the total dredged quantities amounted to 90,000 .cy/yr (68,800 m^3/yr), which was dumped offshore. The 1945 to 2001 bathymetry comparison over Zone 3 indicated an accretion rate of 94,000 cy/yr (71,900 m /yr), *independently confirming* the above estimated dredging activities. The 9,000 cy/yr (6,900 m^3/yr) of sand delivered by the river to the lake and the updrilt supply that bypassed the harbor (i.e_ the sum of Columns iv, v and vi) was mostly deposited in Zone 2b.

Once erosion and deposition of Zones 2a and 2b are considered, only 3,000 cy/yr (2,300 m^3/yr) was delivered to the downdrift shores in this period. The introduction of more shore protection structures reduced bluff erosion causing more lakebed erosion, which resulted in steepening of the beach profile downdrift of the harbor. According to the 1965 survey, the average nearshore bottom slope to the south end of the study area south of the harbor steepened to 1/55. The outgoing LST rate for this steeper slope was estimated to be 243,000 (185,800 m^3/yr) (refer to Section 4,5 for the procedure): The increased contribution of shoreline protection and profile steepening resulted in an increase in predicted or estimated lakebed and bluff erosion to 240,000 cy/yr (183,000 m "Vyr) - see Column xiv. Redistribution of the estimated annualized eroded sand volume of 209,000 cy/yr (159,800 m^3/yr) for the 1938 to 1960 period (Section 4.3.2) and 216,000 eylyr (165,100 m^3/yr) for the 1960 to 2002 period (which would have been about 74,000 cy/yr (56,600 m^3/yr) higher if it was not for beach nourishment works by the USACE) and considering the increase in erosion rates with time, resulted in an estimated average eroded sand volume of 212,000 cy/yr (187,000 m^3/yr) for the 1946 to 1970 period (see Column xii). This estimate of actual lake bed and bluff erosion is within 15% of the value derived from the sediment budget approach with the above estimates of the outgoing LST rate and provides *independent confirmation* of either the LST rate or the total eroded volume. The two approaches to estimating the erosion that would have occurred in the absence of shore protection influences are presented in Columns xviii and xix based Columns xii and xiv, respectively. The estimates of 174,000 and 202,000 cy/y (133,000 and 154,400 m^3/yr) are less than the actual erosion but more than the pre-harbor erosion rate of between 131,000 and 141,000 cy/y (100,000 and 107,800 m^3lyr).

Dams trapped 86,000 cy/yr (65,800 m^3/yr) of sand between 1946 and 1970. Therefore, if the impact of the dams and the shore protection is excluded, the bluff and lakebed erosion would have been limited'to 159,000 cy/yr (121,600 m^3/yr), only slightly greater than the estimated pre-harbor erosion rate.

Columns xxi(a) and xxi(b) show that the harbor impacts are estimated to result in an increase to erosion by 43,000 to 61,000 cy/yr. (32,900 to 46,600 m^3/yr) of sand,

4.6.6 The Period 1970 to 1991

The period from 1970 to 1991 corresponds to the.initiation of the USACE erosion mitigation measures with the placement of 90,000 cy/yr (68,800 m^3/yr) of sand on average on the shore and in the nearshore zone directly south of St. Joseph Harbor and the cessation of offshore dumping of dredged sediments. Lake levels were high during the 1970's and 1980's with new record highs established on Lake Michigan in 1973 and 1986 (based on records dating back to 1860). Many private property owners constructed shore protection during this period, as did many riparians around the Great Lakes, in response to the high lake levels.

Volume estimations indicate a trapping rate of 18,000 cy/yr (13,800 m^3lyr) by the north fillet beach. Navigation channel dredging volume stayed at an average of 30,000 cy/yr (22,900 rn^3/yr). The annual average dredging quantity from Figure 3.8 was 82,000 cy/yr (62,700 m^3/yr), which means that the inner harbor dredging was about 52,000 cy/yr (39,800 m^3/yr), of which 26,000 cy/yr (19,900 in^3/yr) (half) was estimated to be sand. River sediment supply was reduced to 37,000 cy/yr (28,300 m^3/yr) of sand in this period. If the inner harbor sedimentation is considered, 11,000 cy/yr (8,400 m^3lyr) of the river sand found its way to the littoral system. Using sand dredged from the navigation channel and trucked from upland sources, the USACE on average put 90,000 cy/yr (68,800 rn^3/yr) into the downdrift nearshore system.

Therefore, in total, 103,000 cy/yr (78,700 m^3/yr) of sand was made available to the littoral system. Of this total, a net of 6,000 cy/yr (4,600 ra^3/yr) of sand was estimated to be lost to Zones 2a and 2b (i.e. the bypass shoals) resulting in net sand delivery to the downdrift shores of 97,000 cy/yr (74,200 m^3/yr). The average annual erosion rate of sand from the lakebed and bluffs was estimated as 216,000 cy/yr (165,100 m^3/yr) of sand for the 1960 to 2002_ period. It was determined that approximately 54% of the shore featured shore protection during this period and that the nearshore slope was between 1/55 and 1/35 (vertical/horizontal) based on estimates in the prior and later periods. Following the procedure outlined in Section 4.5, the outgoing LST at the south end of the Plaintiffs' properties *was* estimated to increase to 282,000 cy/yr (215,600 m^3/yr). Using the sediment balance approach based on the difference between net quantity of sand delivered to the downdrift shores and the outgoing LST rate, the predicted lakebed and bluff erosion of sand was 185,000 cy/yr (141,400 m^3/yr) for this period. This estimate is within 15% of the independent estimate based directly on bluff and lakebed erosion. The two approaches to estimating the erosion that would have occurred in the absence of shore protection influences are presented in Columns xviii and xix based on adjustments to Columns xii and xiv, respectively. The estimates of 139,000 and 108,000 cy/y (106,300 and 82,600 m^3/yr) are less than or similar to the pre-harbor erosion rate of between 131,000 and 141,000 cy/y (100,000 and 107,800 m^3/yr).

Dams trapped 77,000 cy/yr (58,900 m^3/yr) of sand in this period. Thetefore, if the impact of the dams and the shore protection are excluded, the bluff and lakebed erosion would have been limited to 70,000 cy/yr (53,500 m^3/yr), much less than the estimated pre-harbor erosion rate.

Columns xxi(a) and xxi(b) show the harbor impacts (including the benefit of the beach nourishment program) result in an increase in erosion by 8,000 cy/yr (6,100 m^3/yr) in one case and a reduction in erosion by 33,000 cy/yr (25,200 m^3/yr) in the other case. Both estimates rely on calculations of various parameters, with the Column xxi(a) result being more closely related to the direct estimate of erosion from Column xii.

4.6.7 The Period 1992 to 2005

Finally, the period from 2005 to the present corresponds to a reduction in the average annual beach nourishment rate by the USACE from 90,000 cy/yr (68,800 Ix^3/yr) in the previous period to 42,000 ey/yr (32,100 m^3/yr). According to the SHOALS 1999 survey, the average nearshore bottom slope (between +1 and -5 m LWD contours) from the harbor to the south end of the study area was 1/35 in 1999.

Volume estimations indicate a small trapping rate of 5,000 cy/yr (3,800 m^3/yr) by the north fillet beach. Navigation channel dredging volume averaged approximately 36,000 cy/yr (27,500 m^3/yr). The inner harbor has not been regularly dredged in this period and as a result the average annual dredging quantity dropped to 14,000 cy/y (10,700 m^3/yr). River supply was further reduced to 28,000 cy/yr (21,400 m^3lyr) of sand in this period of which it was estimated that 14,000 cy/yr (10,700 m^3lyr) could find its way to the littoral system. The USAGE on average placed 42,000 cy/yr (32,100 m^3lyr) of sand dOwndrift of the harbor.

Therefore, in total 65,000 cy/yr (49,700 m^3/yr) was made available to the littoral system. Of this total, a net of 6,000 cy/yr (4,600 m^3/yr) of sand was estimated to be lost to Zones 2a and 2b (i.e. the bypass shoals) resulting in net sand delivery to the downdrift shores of 59,000 cy/yr (45,100 m^3/yr). The average annual erosion rate of sand from the lakebed and bluffs was estimated as 216,000 cy/yr (165,100 m^3/yr) of sand for the 1960 to 2002 period. It was determined that approximately 60% of the shore featured shore protection during this period and that the average nearshore slope was 1/35. Based on the procedure outlined in Section 4.5, the outgoing LST at the south end of the Plaintiffs' properties was estimated to increase to 322,000 cy/yr (246,200 m^3/yr). Using the sediment balance approach based on the difference between net quantity of sand delivered to the downdrift shores and the outgoing LST rate, the predicted lakebed and bluff erosion of sand was 263,000 cy/yr (201,100 m^3/yr) for this period. This estimate is within 20% of the independent estimate based directly on bluff and lakebed erosion. The two approaches to estimating the erosion that would have occurred in the absence of shore protection influences are presented in Columns xviii and xix based on adjustments to Columns xii and xiv, respectively. The estimates of 99,000 and 146,000 cy/y (75,700 and 111,600 m^3/yr) are less than or just slightly more than the pre-harbor erosion rate of between 131,000 and 141,000 cy/y (100,000 and 107,800 m^3/yr).

Dams trapped 57,000 cy/yr (58,900 m^3/yr) of sand in this. period. Therefore, if the impact of the darns and the shore protection are excluded, the bluff and .lakebed erosion would have been limited to 118,000 cy/yr (90,200 m^3/yr), less than the estimated pre-harbor erosion rate. -

Columns xxi(a) and xxi(b) show the harbor impacts (including the benefit of the beach nourishment program) result in a reduction in erosion by 32,000 cy/yr (24,500 m^3/yr) in one case and an increase in erosion by 5,000 cylyr (3,800 m^3/yr) for the other estimate. Both estimates rely on calculations of various parameters, with the Column xxi(a) result being more closely related to the direct estimate of erosion from Column xii.

4.6.7 Summary of the Sediment Budget Findings

Since the onset of the USACE beach nourishment efforts in 1970 to mitigate the impacts of the harbor, the natural background erosion rate, in the absence of shore protection effects, has been reduced by 13,000 cy/yr (9,900 m^3/yr) for the 10 mile (16 km) reach south of the harbor (this is the average of the two pairs of estimates from the two periods between 1970 and 2005 in Columns xxi(a) and (b). In contrast, for the period from 1904 to 1970 the harbor impacts have resulted in an increase to the background erosion rate of approximately 55,000 cy/y (42,000 m^3/yr — estimated from the average of the two pairs of estimates for the two periods between 1904 and 1970 given in Columns xxxi(a) and (b)) over the pre-harbor rate of 131,000 to 141,000 cy/y (100,000 and 107,800 m^3/yr). However, compared to the estimated erosion rate between 1904 and 1969 of about 203,000 cy/y (average of 194,000 and 212,000 from Column xii of Table 4.4) the harbor impact amounts to 25% of the total. It must be noted that the extent of erosion impact varies considerably along the 10 mile (16 km) length of the shore from south of the south fillet beach to the south end of the Plaintiffs' properties. The possible harbor impact at the specific locations of the Plaintiffs' properties for the pre-1970 period is evaluated in Section 4_7.

4.7 History of Erosion for Individual Properties

Section 4_6 presented our best estimate of the impact of the harbor and other human interventions on the sediment budget. This information was analyzed to estimate the overall erosion rate for the 10-mile (16 km) reach of shoreline south of the harbor and the contributing factors to this erosion. It was shown that even though the USAGE replaced all of the sand trapped by the haibor since 1970, there has been an increase in erosion in this time period compared to pre-harbor natural erosion rates. This increase in overall erosion is explained by the influence of shore protection on steepening the nearshore profile, increasing the LST gradient and the resulting erosion. It is explained in Section 4.5 that the domino effect of the implementation of shore protection, starting with the C&O Railway protection, leading to the MDOT protection and subsequently to riparian protection of shores to the south was not influenced by the harbor impacts on erosion. It was determined that without the influence of shore protection the erosion since 1970 would have been less than or equal to the pre-harbor erosion rates. Therefore, it is our judgment based on these analyses that the USAGE fully mitigated the impacts of the harbor after 1970.

For the period prior to 1970, there had been a steady increase in the erosion of the shoreline downdrift of the harbor from 131,000 (107,800 m^3/yr) in pre-harbor times to

between 4000 and 2500 years ago, expect for brief periods of stability (Arborgast et al. 2002; Loope and Arbogast 2000), in some places, most notably the northern end of the embayment, small coastal dunes are still forming today and are locally burying modem beach sediments and coastal vegetation.

<u>Grand Mere Lakes</u>

The Grand Mere Lakes are relatively shallow and the result of ponded drainage behind the Lake Michigan shore. They are rimmed by organic sediment and drainage from the lakes cascades north from one lake to the other, finally discharging west into Lake Michigan.

Recent borings by the U.S. Geological Survey (Stone et al. 2003; Peters site) at Grand Mere State Park located along the south shore of North Grand Mere Lake show about 16 ft (4.9 m) of fine sand interpreted as *aeolian* in origin, followed by 18 ft (5.5 m) of sand and sand and gravel interpreted as lacustrine, and about 10 cm of peat and logs that rest on 43 ft (13.1 m) of till. The peat and logs occur about 7 ft (2.1 m) below the modem mean level of Lake Michigan and have been radiocarbon dated as 6,675 and 6,640 years old (5,870 and 5,810 ±40 years BP[2]; Stone et al. 2003). The dates indicate that the northern end of the embayment was above lake level and vegetated sometime before 6,675 years ago and that, some time after 6,640 years the embayment was flooded, probably by rising water associated with Lake Nipissing. The dates also indicate that the large coastal dunes within the embayment did not develop until lake level dropped

[2] Age of peat and logs in radiocarbon years ("C) before present (BP). Because "C years and calendar years are not exactly the same, 14C dates are usually converted to calendar years using a correction factor based on long-term tree ring analysis and/or other independent dating techniques.

sometime after 6,640 years ago. A boring (LT-1-94) by the Corps of Engineers along the modem Lake Michigan beach and near the outlet for Grand Mere Lakes also shows soft black organic silt 3-15 ft (1-2.5 m) below the level of Lake Michigan. In addition, rafts of peat are commonly found washed up along the Lake Michigan lakeshore near Grand Mere Lakes (Figure 9). These rafts suggest the organic layer extends some distance into Lake Michigan and is being eroded by wave turbulence. A recent radiocarbon analysis of one of the rafts has yielded a date of 6,980 years (6040±60 years BP[3]).

Natural Erosion of the Berrien County Lakeshore since Deglaciation

The lake bluffs north and south of St. Joseph are eroding and have been **periodically eroding for a long time. To illustrate this point one need only compare the** lake bluffs seen today with those painted by George Catlin in 1848 when he composed a scene of La Salle's exploration party of 1681 sledging their canoes over the barron frozen surface of Lake Michigan near **St. Joseph. Catlin traveled extensively in the Great Lakes during the 1830s and had a great eye for detail. For example, he even shows trees falling from the top of the eroding** bluffs towards a **narrow beach, much like what is seen** today.

Several studies have attempted **to estimate the amount of lakeshore erosion that has occurred in Berrien County since European settlement (Powers 1958; Buckler and Winters 1983, Buckler et al. 1988). These are based mainly on historical land surveys and** offer useful information about short-term shore erosion. However, they provide little to no information about long-term shore erosion, particularly over hundreds to thousands of years. Nevertheless, clues about long-term shore erosion are present in surficial geologic

[3] **Age of peat in radiocarbon years before'present (BP).**

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Open water	
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[illegible]	[illegible]	[illegible]	'1000' lo 4000' south of the South frier	[illegible]	open water		
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	[illegible]	[illegible]	'Center ni Park SIL Extended Then - 34001_,F,"	[illegible]	[illegible]		
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[illegible]				[illegible]	[illegible]		

1988	43726	40725	"The disposal consisted of approximately 3,000 C.Y. upland on LECO Corporation's Silver Beach area within dikes and the remainder was disposed along the southerly shoreline between Park Street extended and the water plant."	3000	"The disposal consisted of approximately 3,000 C.Y. upland on LECO Corporation's Silver Beach area within dikes and the remainder was disposed along the southerly shoreline between Park Street extended and the water plant."	67500	3	$ 291,446	5	$ 265,659				
1989	18745	18745	"centerline of Park Street extended to 2,700' south of the centerline of Park Street"				3	$ 147,725	5		5000	Upland site	Not specified	
1990	58314	58314	"centerline of Park Steet to 2,700' south of the centerline of Park Street"				3	$ 317,067	5					
1991	62738	52513	"center line of Park Street, and extending 2,700 feet southward"	10225	Whirlpool CDF	83383	3	$ 278,160	5	$ 424,318				
1992	63108	33644	"shoreline from south edge of Park Street and extended 2700 feet southward"	29464	Whirlpool CDF		3	$ 123,324	5					
1993	2360	2360	"shoreline from 50 feet south of Park Street and extending 2,500 feet southward"			60025	3	$ 13,185	5	$ 284,522				
1994	31391	31391	"shoreline from 18,300 to 19,700 feet south of the south pier"				3	$ 439,744	5					
1995	33335	33335	"50' south of the centerline of Park St. and continued 2500' south along the shoreline."			63355	3	$ 185,008	5	$ 308,166				Shoreham stone placed
1996	24918	24918	"shoreline from 50 feet south of the centerline of Park Steet, and extending 3,000 feet southward."				3	$ 199,738	5		760	Upland site	Not specified	
1997	65738	35042	"shoreline from 60 feet south of Park Street and extending 1500 feet south"	30696	Whirlpool CDF	35042	3	$ 158,877	5	$ 316,037				
1998	24485	24485	"500 feet south of Park Street and extending 2700 feet south along the shoreline."			33333	3	$ 147,154	5	$ 251,100				
1999	45671	22482	"500 to 3200 feet... south of Park Street along the shoreline."	23189	Whirlpool CDF		3	$ 171,367	5		300	Upland site	Not specified	
2000	39472	39472	"500 to 3200 feet... south of Park Street along the shoreline."				3	$ 259,931	5		6280	Upland site	Not specified	

A.8148

[illegible]	'50 to 1200 feel— south or Park Street atin• the shoreline,
[illegible]	"shoreline starling al 1,200 feel south of the centerline of Park Street eirlendrng southerly 1,300 feet"
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	"50 feel_ south of the centerline of Park Sheet and extending Southerly
[illegible]	[illegible]

Source of Dredge Data
1 - Annual Reports to Congress
2 - Draft Environmental Statement, Confined Disposal Facility, Dredging and Mainenance Operation for St. Joseph Harbor, Michigan, September 1977
3 - Record of Construction, Grand Haven Area Office
4 - Summary of Daily Reports (1975-1986)
5 - Corps of Engineers, Detroit District Web Page
5* - Corps of Engineers, Detroit District Web Page - Includes cost of material placed in CDF and/or open water
6 - Personal communication with USACE, Grand Haven Area Office
7 - See Regulatory Permits (Bates numbers BDM-PM001051 to PM001163) for further information

Technical Report CHL-97-15
July 1997

US Army Corps of Engineers
Waterways Experiment Station

Effectiveness of Beach Nourishment on Cohesive Shores, St. Joseph, Lake Michigan

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Andrew Morang, Larry E. Parson, WES

Prepared for Headquarters, 1J,SL Army Corps of Engineers

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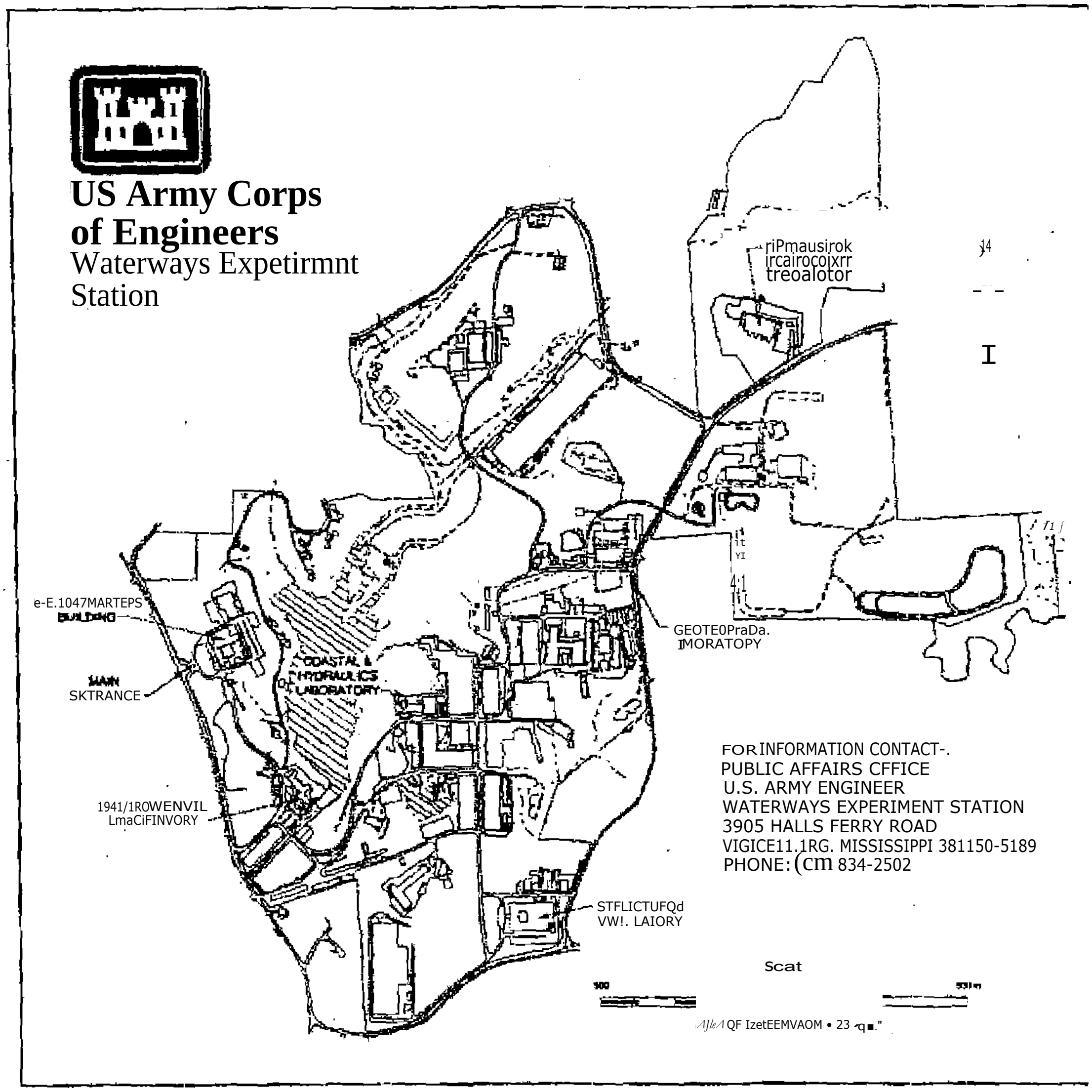

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sediment along the shore has properties of cohesion, the content is predominantly sandy. The predominantly sandy nature of the shore over-rides the cohesion properties in some of the sediment in defining this shore as predominantly sandy, The reasons for this are explained under points 1 to 3 above, and in simple terms is a result of the much greater wave energy required to remove the heavier sand grains to allow erosion to continue (whether it is erosion of underlying sandy or the relatively few occurrences of cohesive sediment), [See Sections 2.1 and 22].

5. A quantitative methodology using the sand content of the bluff and nearshore was applied on a property-by-property basii to determine which properties feature a cohesive shore and which were predominantly sandy. The sand content of the bluff and lakebed was originally determined by Larson (2006) and refined by Mickelson (2009) considering the results of Mackey (2009) among many other data sets. The literature on cohesive shores indicates that cohesive shores have a sand content of less than 30%. The nearshore zone of the Werger property features sand content between 41% and 48%. Although this is above the 30% threshold from the literature, it is my expert opinion that this cannot be classified as predominantly sandy. Of the Plaintiffs' properties, only the Werger property [illegible] classified as a cohesive shore. The remaining properties featured sand [illegible] and 85% and are, therefore, predominantly sandy. [See Section 4.21.

6. The independent line of evidence that the shore along the Plaintiffs' properties beha[illegible] sandy shore consists of the fact that the sand budget completed by Nairn (2006) quantitatively determined the observed rate of erosion (the latter determined from documented bluff and lakebed erosion rates). In other words, the erosion was explained by the net loss of sand from an area of interest through longshore sand. transport processes. This would only occur if the shore was predominantly sandy, and not cohesive. pee Section 3.2].

7. For predominantly sandy shores located downdrift of a harbor, a beach nourishment program that fully compensates for the net impact of harbor structures and related dredging activities will ensure there is no erosion impact In other words, if a quantity of sand (and gravel) equivalent or greater than the sum of any sand (and gravel) trapped or removed from the littoral system is re-introduced downdrift of the harbor, to be available to supply the downdrift shores, the impacts of the harbor will have been fully compensated. South of St. Joseph Harbor, this has been the case since 1970, as shown by Nairn (2006). [See Section 3.2].

8. The sand budget completed by Nairn (2006) was revisited in light of the courrs September 28, 2007 decision that the coarse fraction of the tracked sediment for beach nourishment was not effective. The grain size characteristics of the trucked sediment were reviewed and it was found that 50% of the trucked sediment placed was indeed sand. Therefore, the sand budget was re-evaluated with only 50% of the trucked sediment considered as effective. It was found that the sand budget approach still effectively explained, in a quantitative manner, the rate of erosion of the shore in the zone of the Plaintiffs' properties. In other

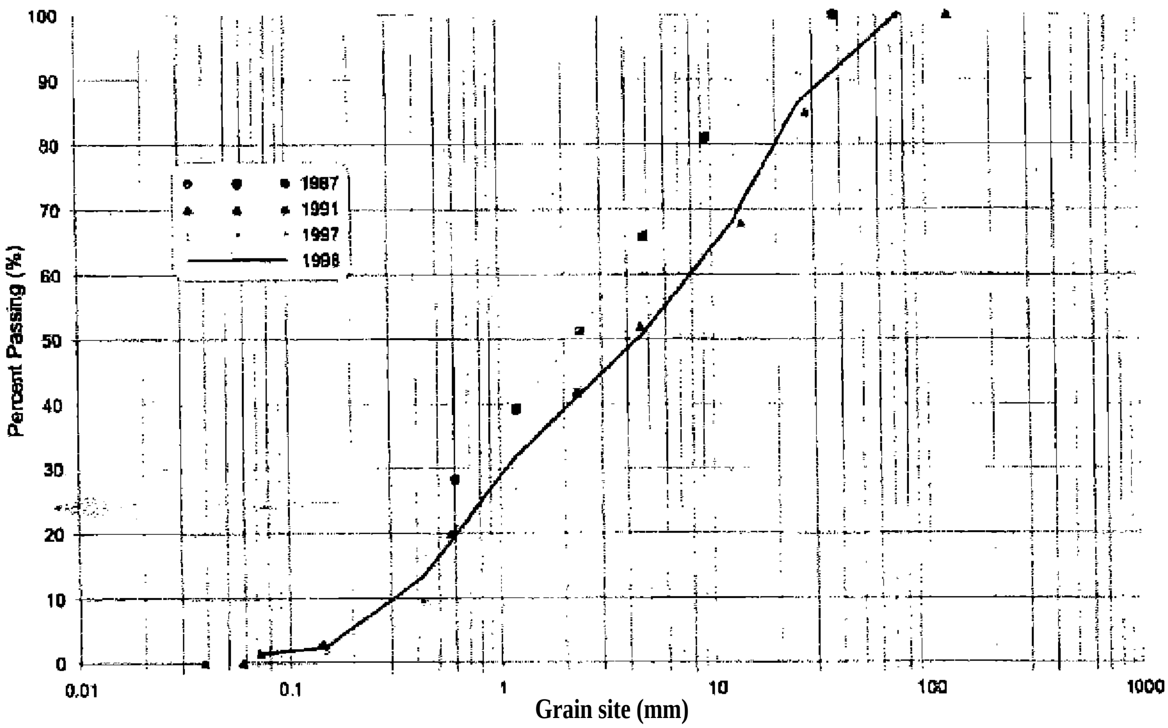

Figure 3.1 Grain Size Distribution for 1957,1991,1997 and 1998 Trucked Sediment nth

Figure 3.1 shows that at least 50% of the trucked sediment is sand finer than the 4.73 mm limit between sand and gravel for all four of the fills, The gravel content ranges from 4.75 mm up to 70 to 100 mm. However, 96% to 99% of the gravel is in the 4 to 64 nun range.

There are several ways to determine the upper cut off of effective grain size for beach nourishment:

1. **The September 2007 court decision implies it should be based on the definition of sand vs. gravel - there are two possible thresholds based on two different classification systems: 2 mm for the Wentworth classification (Wentworth, 1922) and 4.75 mm for the AStM standard (ASTM international standards - formerly the American Society for Testing and Materials and originally presented by Casagrande, 1948). The latter ASTM standard is mostly used by engineers.**

2. **Consider the characteristics of the sediment on the beach and nearshore of the Plaintiffs' properties. Recent visits to the beaches in the zone of the Plaintiffs' properties reveals significant quantities of gravel on the beach and in the shallow water just offshore of the beach (see Figures 32 and 3.3), Although there is no way of telling for certain, the presence of significant quantities of gravel on the beach and shallow nearshore most likely points to this being naturally derived (see Point 3 below and considering the last trucked sand nourishment was 11 years ago in 1998). Figure 3.4 is reproduced from Figure 8 of Parson and Bailey Smith (1995) and shows that approximately 10% of the sand and gravel on the**

beach and nearshore consists of gravel in the size range of 4 to 22.5 mm. The same report notes that the sampling methods probably under-estimate the quantity of the coarse sediment fraction (i.e: the gravel). In my experience, most sandy beaches on the Great Lakes feature a significant gravel size fraction.

3. Consider the sediment that was supplied historically through natural erosion of the bluff and nearshore along the study area shoreline. Tables 2 to 4 in the report of Mickelson (2009) document the grain size distribution of the three primary eroding stratigraphic units in the northerly two thirds of the study area shore (i.e. that would supply beach material to the full length of the study shore): Ganges Till which has very little sediment larger than 4 mm, Saugatuck Till features 10.6% gravel content between 4 mm and 64 mm and the Stratified Sand and Silt consists of 12.8% gravel between 4 min and 64 mm.

4. Consider the guidance for beach nourishment project provided by the US Army Corps of Engineers Coastal Engineering Manual, Part V of Chapter 4 on Beachfill Design (Cravens et at, 2008). Regarding grain size characteristics of the fill material, the fundamental recommendation is Most often, *sand with grain size characteristics similar to those of the native beach is sought as beach-fill*" (see paragraph (4a) of Section 4.1c on p. V-4-8 of this design manual). Later in the same paragraph it notes that: "*Sometimes the choice of nourishment material with different characteristics is made W satisfy a particular design objective, such as use of coarser-grained material to improve resistance to erosion*¯. Section 4.1e, paragraph (a) on page V-4-11 notes that terrestrial or upland sources for nourishment are acceptable. Section 4.1e, paragraph (h), page V4-25 on beachfill sediment suitability states "*Fills with coarser material provide improved resistance to storm-induced erosion*".

3.2 Review of Implication of Sand Budget on Shore Type Definition Considering Effective Fraction of Trucked Sediment

There are two aspects to consider with respect to the revised sediment budget, if it is accepted that only 50% of the trucked sand is effective as compensation. (As noted in Section 3.1, on a purely technical basis and in the opinion of this expert, the trucked sediment is 100% effective as compensating beach nourishment). The two considerations are:,

1_ Was the quantity of trucked and dredged sediment sufficient to compensate for the impact of the harbor structures and operation? Columns (xxi-a) and (xxi-b) of Table 3.2 present the impact of harbor and operations on erosion of the downdrift shore. Only the values in the second of these two columns change as the values in the first are related to a direct estimate of what has occurred without the impact of shore protection_ With the revisions, there was a surplus of sediment supplied in the 1970 to 1991 period of 17,000 cubic yards per year and a deficit of 12,000 cubic yards per year in the period 1992 to 2005. Therefore, for the entire period from 1970 to 2005 more sand was supplied than necessary to compensate for the impact of the harbor and operations.

2. The second point relates directly to the purpose of this report, which is to review the shoreline composition, and specifically which parts of the shoreline are cohesive or sandy on a property-by-property basis. In this respect, it has been explained that if the total erosion in the study area matches the predicted erosion based on the longshore sand transport (LST) gradient, then the shore is behaving like, and may be.defined as, a sandy shore. The numbers in the last two rows of Column ()di) of Table 3.2 represent the actual erosion of bluff and lakebed sand for the 1970 to 2005, estimated at 216,000 cubic yards per year. These estimates may be compared to the estimate of erosion based on the gradient in longshore sand transport (LST) given in the last two rows of Column (xiv) giving an average of about 235,000 cubic yards per year. Since this estimate based on the LST gradient is similar or slightly larger than the actual eroded volume of 216,000 cubic yards per year, this shore may be considered to behave as a sandy shore, even when the gravel fraction of the trucked sand is not considered effective as nourishment. It is interesting to note that when all of the trucked sediment is considered effective (as is technically supported by the literature) the comparison is much doser with an average of 224,000 cubic yards per year eroded based on the LST gradient (i.e. compared to the estimated loss of 216,000 cubic yards per year). This observation provides additional and independent evidence that 100% of the trucked sediment is in fact effective as beach nourishment.

Cat Island Chain Restoration
Green Bay, WI (2003-2005)
Dr. Nairn was the project manager for the conceptual and preliminary design phases ofthis project. The plan is to use dredged sediment from the Green Bay access channel to reconstruct the Cat Island Chain that eroded and disappeared over the last twenty years. Tasks included numerical modeling at waves and currents, sediment plumes and evaluation of historic dredging and sedimentation and natural island design.

Halton Intake Siting Assessment
Lake Ontario (2003-2004)
Dr. Nairn was the project manager for the assessment of the evaluation of siting of a new water intake at this location, as it related to the impact of nearby rivers emptying into the lake Baird completed numerical modeling of three different rivers emptying into and mixing with the lake, including hydrodynamics and advection/dispersion of plumes. Baird also completed extensive GIS analysis and water quality and current measurements to provide input, calibration and verification data.

Michigan City Harbor Investigation
Indiana ***(2004-2005)***
Dr.Nairn was the Principal-in-Charge for the assessment of the impact of this harbor on littoral drift along the south coast of Lake Michigan. The investigation included numerical modeling of the liver flow and interaction with lake hydrodynamics. Two-dimensional sediment transport modeling was completed in order to represent morphodynamic changes over more than 130 years. GIS analysiS was completed of lake bed and shoreline change.

Mauritius Coastal Erosion Study
Mauritius, Indian Ocean (2003)
Dr. Nairn was the Principal-in-Charge and the leading technical advisor on this project to assess the root causes of coastal erosion on this southern Indian Ocean island state. His role included managing modeling of waves for the entire Indian Ocean, cyclone waves and surge, wave transformation across the reefs and longshore/cross-shore transport of sand and beach erosion, A new method for quantifying the supply of sand from coral reefs as part of an overall sediment budget was developed and tested against long-term shoreline change from recent and historic air photos. This lead to the design of solutions to erosion problems consisting of beach nourishment as an interim measure and restoration of reefs (to augment sand supply and protect front waves) as the long-term solution.

Barbados Coastal Infrastructure Project
Barbados, West Indies (2002-present)
Dr. Nairn is the project manager for the largest of eight waterfront rehabilitation projects Baird is currently designing and providing construction services on. The LISDS million Rockley Beach project consists of beach restoration through the construction of natural headlands and beach nourishment, In. addition, Dr. Nairn managed the investigation of beach stability and related coral reef health at two other locations on the island as input to the Coastal Zone Management program on the island. These various studies were based on extensive field investigations, numerical modeling of waves (including hurricanes), surge, currents and sand transport.

Egypt LNG Terminal ***(2004)***
Dr. Nairn completed a review of the sedimentation in the approach channel associated with this recently constructed LNG terminal on the Nile delta in Egypt. The review consisted of analysis ***of*** the channel infilling data and consideration of the waves, currents and sediment transport patterns.

Canein Beach Nourishment Project
Cancun Association of Hotels (2004)
Dr. Nairn provided technical advice to the Baird team regarding the erosion of the Cancun beaches and the potential linkage to degradation of nearshore coral reef health. Dr. Nairn also evaluated the borrow deposits consisting of offshore sand banks for this 2,50,000 rn^3 beach nourishment

To determine the land area, shoreline frontage, and the Ordinary High Water Marks at various dates in the past and into the future used in this report, we have relied upon information researched by the engineering firm of W. Baird & Associates, which was contracted by USDOJ to, in part, provide that information for us. As real estate appraisers, we are neither trained nor qualified to determine the validity of the procedures used in collecting their data, the methodologies used in analyzing that data, nor the veracity of their conclusions.

In cases where we have conflicting information on land areas or frontages between Baird and recorded deeds, we have attempted to discover the reason(s) for the conflicting data and reach a consensus, and then we have utilized the figure that benefits the property owner. For instance, if Baird gives us a subject property owner lake frontage number that is lower than the number on the deed, we notify Baird and they recheck their calculations. - If the numbers are still lower than the deed numbers, we use the deed numbers. Conversely, when we evaluate comparable properties, we will use the lower number, as that reflects a greater price per front foot value, which gives the benefit of the doubt to the property owner It should be noted that when we discovered these discrepancies, we spoke with a local (Berrien County, MI) engineering firm, Wightman & Associates, and they basically stated that on two different days, their numbers for shoreline frontage on the same parcel could be different. Additionally, when realtors list property they may list a `front foot" number that could come from any number of sources and the market may or may not react to that particular number. The important point we are making is that when given conflicting data, we utilize the numbers that generate the greatest benefit for the property owner.

As this appraisal is also retrospective with an effective date of appraisal of January 2000, the appraisers are limited in their ability to evaluate both the subject and the comparable properties as of that date. Interviews with owners, parties to the sales, discussions with brokers, aerial photography, and analyses of multi-list data and public records are methods used by the appraisers to get as accurate a picture of the subject and comparables as possible. It should be noted that because this report is an appraisal of a

The market value test, as a result of the fundamental Principle of Anticipation, already intrinsically includes any consideration of Reasonably Foreseeable Future Damages. And as the market data indicates, there is no adverse market condition to these anticipated events and the perception of risk of future erosion.

> "(T)he extent to which the utility of a property has been destroyed and its market value diminished must necessarily be established by factual data having a rational foundation in support of such a claim." (Yellow Book Page 49)

> "Because the fundamental basis of a claim of severance damages is a diminution in the value of the remainder land, the law is that "strict proof of the loss of market value to the remaining parcel is obligatory." (Yellow Book Page 49)

Reasonably foreseeable future losses, to the extent that they impact value (and damages) are reflected in the difference in market value between the property before and after the taking. Reasonably foreseeable future losses from erosion basically could consist of perceived future losses of property. It is clear to the extent that a perceived future risk of erosion, as would be anticipated in the subject market after January 2000 or as would be anticipated in the Ludington Pumped Storage impact study (included in my appraisal reports) because of the easement, would be considered by the market as of the date of taking based upon the Principle of Anticipation. This is also consistent with the "one recovery rule" in condemnation.

I would reference the following sales of properties that occurred after the taking. Most of these sales were sold by or purchased by plaintiffs with full knowledge and ability to anticipate reasonably foreseeable future losses from erosion. They clearly indicate a substantial market value after the January 2000 date of taking. They also clearly indicate that anticipation of or speculation into future damages has no impact on the market value of the property.

Summary with Identification and Estimated Market

Banks, et al. v. United States (Fed. Cl.)

Date of Purchase	Address	After Value
[illegible]	[illegible]	[illegible]

Name	Date of Purchase	After Value
DelMariani (N)	[illegible]	[illegible]
Del Mariani (S)	[illegible]	[illegible]
Miller (N)	[illegible]	[illegible]
Miller (S)	[illegible]	[illegible]
Ragins	[illegible]	[illegible]
Morvis	[illegible]	[illegible]
Chapman	[illegible]	[illegible]
Errant (Saphir)	[illegible]	[illegible]
Notre Dame Path Assoc.	[illegible]	[illegible]
Country LLC	[illegible]	[illegible]

claim of which it should be aware is not enough to toll the statute. Coastal Petroleum Co. v. United States, 228 Ct. Cl. 864, 866 (1981). Furthermore, "[w]here the actions of the government are open and notorious, we have pointed out that plaintiff is on inquiry as to its possible injury. Once plaintiff is on inquiry that it has a potential claim, the state of limitations begins to run." Id, at 867 (citations omitted).

The controlling case for establishing when a claim for erosion accrues and the statute of limitations begins to run is Baskett v. United States, 8 Cl. Ct. 201 (1985), aff' d 790 F.2d 93 (Fed. Cir), cext. denied, 478 U.S. 1006 (1986). Baskett held that the riverbank need not be completely washed away before the statute begins to run. The court enunciated three disjunctive circumstances in which the statute of limitations begins-to run:

1) Had the consequences of the inundation so manifested themselves that **a** final account could have been made of the damage?; or

2) Was the damage a foreseeable future event?; or

3) Were the effects of the dam fully known by the landowners (i.e., actual knowledge?)

See 8 Cl. Ct. at 231. The court noted that many plaintiffs became aware of erosion shortly after dam installation. Even if the plaintiffs in Baskett did not have actual knowledge of the erosion. "often the mere passage of time is sufficient to presume that some **of** the erosion damage complained of would have manifested itself" 8 Cl. Ct. at 231.

In sum, a plaintiff definitely cannot postpone suit until the erosion damage is complete.

ARGUMENT

1. All Of The Plaintiffs' Claims Are Out Of Time Based Upon Their Own Pleadings And Subsequent Submissions.

Beginning with the original and Amended Complaints, plaintiffs' allegations indicate that their claims accrued many more than six Years prior to the filing of these suits in 1999 and 2000. bathe original complaint filed on July 9, 1999, they assert that the defendant constructed and maintained a series of jetties on the east coast of Lake Michigan north of their properties fOr over 100 years. They contend that these structures have altered the littoral drift of sand which used to migrate south and gravitate to their shoreline to now become trapped around the jetties. They go on to allege that the Corps of Engineers dredges these accumulations and transports them out to

deep water in the Lake where they are no longer able to drift down to plaintiffs' properties. This, they conclude, results in severe bank erosion. Pis' Complaint, para. 26-30. These allegations, when taken as true for purposes of this motion, indicate that the erosive processes and their alleged cause have existed for many, many years

On February 23, 2000, new amended complaints were filed to reflect th6 severability of the individual claims from each other along with the addition of some eighteen more claimants of eastern shore property alleging similar erosive processes to their banks based upon the same theory of causation. Although paragraph 26 of the original pleading is not present in these claims regarding 100 years of jetty construction , maintenance and erosion, the present complaints now narrow the focus of causation to certain jetties located at the harbor at St. Joseph, Michigan which lies north of all of the subject properties. The pleadings go on to recite that these jetties reached their present length back in 1901 They modify their earlier theory of causation by now claiming that the jetties did not interfere with their littoral drift of sand until the Corps began a program of installing steel sheet piling in 1950. This material prevents the drift of sand from passing through the jetties and proceeding south along the eastern shore toward plaintiffs' lands. The sheet metal installation program lasted until 1989_ NS' present complaints, para, 5-10. Accepted as true for the sake of defendant's motion, and further accepting as true plaintiffs' further allegation that their shoreline south of St. Joseph harbor is in recession at the rate of about two feet per year, it must be concluded that by 1989 or eleven years prior to the filing of these claims, these plaintiffs or their predecessors sustained a loss of almost eighty feet of shoreline and bank. Based upon these allegations, defendant urges that injuries of this magnitude as quantified by plaintiffs themselves, cannot reasonably be categorized as "inherently unknowable" for purposes of establishing a date of claim accrual from which the Statute of Limitations would begin to run, Moreover, plaintiffs' properties consist primarily of residential structures lying on relatively small parcels of land_ See: Complaints, Exhibit A, Damages. Therefore, the loss of an average of two feet per year, even if not consistent from one year to the next, is an ongoing process of an inevitable and recurring nature so that over a four decade period, the extent of such land loss could not be ignored by a reasonable and prudent property owner exercising ordinary diligence. Accordingly, based solely upon plaintiffs'

pleadings without more, the test for claim accrual under the test of Baskett v. United States, *supra*, leads to the inescapable conclusion that these claims accrued and the statute ran many years before these plaintiffs came to this court,

In addition to the plaintiffs' pleadings, other documents and filings of the plaintiffs reveal the staleness of their takings claims. Exhibit X to the parties' Appendix G Joint Preliminary Status Report filed with the court in November, 1999 is a map of Lake Michigan with the title, "Figure 1. Location of Federal Projects on East Shore of Lake Michigan." This exhibit is referenced in plaintiffs Item no_ 9 under paragraph h in which plaintiff and defendant's counsel state their versions.of the relevant issues in the case. Exhibit X depicts the years in which the Corps of Engineers dumped sand in the open waters of the Lake from all of the eastern shore harbor areas as well as the number of cubic yards of sand obtained from each of these harbors. Of particular importance to this case are the notations with respect to St. Joseph harbor. Here, the exhibit states that such open water dumping of sand has taken place over a twenty-year period running from 1963 to 1983 or at least seventeen to thirty-seven years prior to the filing of the subject claims. The exhibit also relates that alinost 2 million cubic yards for open water dumping were acquired from the St. Joseph harbor during this twenty year period. Again, the relevance of this data to plaintiffs' claims is that they allege that defendant's jetty structures at St. Joseph harbor are trapping sand and disrupting the littoral drift of this material towards plaintiffs' properties to the south. The Corps then periodically dredges these sand accumulations, at the jetties and transports them out to deep water in the middle of the Lake where they are dumped. Exhibit X furnished by plaintiffs is, like the aforementioned allegations of the plaintiffs' pleadings, another compelling reason why these clsiins have long been time-barred.

In Plaintiffs Answers To Defendant's First Set of Interrogatories served on October 30, 2000, plaintiffs respond to defendant's request to list all experts plaintiffs expect to call at trial and to set forth the substances of the facts and opinicinsforming the bases of their testimony. (See: Exh. no. 1 attached). At answer 1(B), plaintiffs relate that Boyd and Ehret will address a mathematical model done by the Corps of Engineers. Ehret will show about 40, 000,000 cubic yards of sand loss at St. Joseph harbor since 1900. Again, as he.alleged in his original complaint,. Mr. Ehret is reaching back over 100 years to attempt to prove that the corps jetty structures are

suit under the Federal Tort Claims Act in the Western District of Michigan federal district court alleging-that erosion due to the Corps' construction, maintenance and continued use of the harbor entrance facilities at St. Joseph were causing severe damage to their downshore properties. De's Exh. No. 5. The court noted **that** a littoral drift from north to south of sand was interfered with by these structures according to the plaintiffs just as the current plaintiffs contend. These properties lie in the same county as the present plaintiffs' lands and are in close proximity to them. The court dismissed the suits on the basis of the discretionary function exception to liability under the FTCA. 28 U.S.0 Sec. 2680 (a). While defendant is riot suggesting that the plaintiffs are precluded from pursuing their claims for a taking in this court, the district court litigation is offered to show that these plaintiff's must have been aware of their erosion and that their neighbors were litigating claims for such injuries against the defendant more than 18 years ago,

Finally, as even further proof of the long-standing existence of erosion, defendant directs the court's attention to a non-governmental study, <u>Beach Erosion in Michigan. An Historical Review</u>, by Professor Ernest F. Brater of the University of Michigan Def s Exh. No. 6. Besides the graphic photos showing erosion, particularly in the Shoreham area as early as 1950 near plaintiffs properties, Prof. Brater concludes by noting that severe erosion of the late 1940's and 50's occurred during slightly below average lake levels. This would indicate that erosive processes preceded plaintiffs' theory that such erosion only began after the commencement of sheet piling maintenance by the Corps in 1950.

<u>CONCLUSION</u>

For the foregoing arguments and authoritiesr-this court should dismiss these claims under the Statute of Limitations as time-barred by many years.

Dated; February 9, 2001

Respectfully submitted,

an Brenner
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Environment and Natural Resources Division
General Litigation Section
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INTERROGATORY NO. 2

With respect to each expert named in your response to interrogatory No i, please

. state. in detail:

A. The subject matter upon which the expert is expected to testify;
ANSWER: Please see answers to Interrogatory No. 1.
13. The substances of the facts and opinions upon which the expert is expected to

testify: and

C. A summary of the grounds for each opinion_

ANSWER "B" meadows, Chrzastowski, Pilkey and Barnes are all preeminent in the field of littoral barriers, shore parallel protection against erosion, wave energy, data collection; subaerial/subaquatic beach equlibrium, sediment balance modeling, depth **of closure,** dominant littoral drift and transportability of sand. Visual observations, topo-graphic maps, aerial photographs and surveys are the prime source of littoral facts.. Because of their broad academic and field experience it is expected that their testimony will easily include but not be liMited to the above. Add dredging.

Boyd and Ehret address the Corps mathematical models for erosion attributability and present Boyd's model. Ehtet will show about 40,000,000 cubic yards of sand loss at St. Joseph Harbor since 1900. Factual basis will be historic .. photographs, surveys, visual observations and geometric calculations. Also Dredging losses. Calculations are **in** close

agreement with Corps Technical Report CHL-97-15 (Effective Beach Nourishment at St. Joseph, Lake Michigan) where Table 6 shows approximately 400,000 cubic yards per year total (North and South) littoral drift for easily 100 years.

Ehret will address the location of the OHWM (Ordinary High Water Mark) based on horizontal and vertical scaled aerial photographs available from Berrien County. He will also address unscientific design of the Corps piers as total littoral barriers and obstructions tO navigational safety. Facts will include the small amount of commercial boat traffic compared to the recreational traffic.

Voss will prOvide economic loss information associated with loss of access to the lake due to no beach and impassable revetments.

Ward 's testimony may not be required if we get adequate river sediment data concentration and flow.

ANSWER "C" Without the total littoral barrier, without the deep dump dredging,without the bypassing and deep delivery of river sediment there would be little to no erosion. In fact, with wide beaches the winds would rebuild the foredunes and bluffs with aeolian sand. It takes only 1,000,000 cubia yards of sand to build a beach 1 mile long, 200 feet wide and 25 feet high.

13. The Federal Structures were built to stop the forming of a sandbar across the entrance channel.

14. This objective has failed in that the funnel shaped channel entrance was in filling during 1945 to 1965 (CHL-97-15 page 80)

15. In the period 1970-91 in filling forced the dredging of 70,000 cubic meters per year (91,555 cubic yards per year) (CHL-97-15 page 81) from the channel entrance.

16. Prior to 1970 all dredgings were dumped deep beyond the point of return.

17_ The combination of the long jetties and the deep navigational channel acts as a total littoral bather, trapping all sediment reaching this area (St Joseph Harbor) from either the north or the south.

18. Coarse sand being used at the feeder beach is being captured by the deep depression offshore (CHL-97-15 page 18).

19. Coarse sand results in 25% reduction in of along shore transport as compared to 2 mm beach sand, (CI-1L-97-15 page 22)

particularly that ft's been raised is very reflective and a very confused harbor entrance from a wave standpoint.

0: Actually it accelerates the hazard of the waves when you are trying to enter the harbor, doesn't it?

A: Yes, it does.

CI: Is there a rule of thumb that you would use to say how much accentuation of the wave height that occurs?

A: That certainly can be calculated. Generally if we are able to make it in our survey boat out of the harbor, we usually End good conditions for surveying out in the big lake.

CI: As a Coast Guard liceused captain, do you feel that — let me come back to that question.

We took the deposition of the Coast Guard chief who was in charge of the station in St. Joe. His name is Ellison, chief boatswain mate Ellison, ELLI S O N, and we asked him how many incidents a year he had when they had to go out into the lake to answer a distress call, and he produced records, this was a document deposition, 99 percent. He produced records of over a hundred incidents a year for the last six or seven years_

Would you think that some way to get through the pier wouldn't be an addition safety-wise for the — if there was a gap in the pier so that the Coast Guard could go through the gap and head north or south instead of going straight out into the lake, wouldn't you think that would be a contribution. to *safe* conditions? ,

A...I don't see — and I'm not directly answering your question and I'm not trying to be evasive. I don't see how a gap could be nuahltahred.There is such a large volume of sediment being transported towards the harbor from the north that any gap in the harbor would be totally filled in very quickly:

The reason the harbor sticks out as far as it does is to get out to deep enough waters° . . on that maintenance dredging, and agreed for the convenience of Corps of Engineers and public expense, is kept to a minimume

The adverse impact of that is that the harbor is almost a total littoral barrier as we talked about earlier preventing any natural transport of sediment, any significant transport of sediment around the outside of the harbor.

So, the harbor is very effective at blocking that material being provided from the north

and at the expense of the downdrift beaches.

CI: If there were an equivalent gap on the north to a gap on the south, wouldn't a lot of that sand be carried right across the channel?

A: If there is structure beyond the gap, it will act to shadow the waves. It will break those waves and there will be less wave energy to pick that same equivalent volume of sand up.

Any time there is a gap or a detached breakwater like at Michigan City, for example, there is a significant accumulation of material behind that structure. So, again, I believe that the harbor entrance would become ineffective if there was a gap in the wall. .

CI: So, based then on what you are saying, would it be logical to say that the harbor structures are being maintained for the convenience of the Corps's dredging budget?

A: Those harbors as I said existed as commercial harbors, and this one does as well.lt is my understanding the Corps of Engineers only does what Congress directs them to do, and there is certainly a strong shipping interest in the Great lakes and there is a strong recreational value to these harbOrs.

The further the harbor jetties stick

out into the lake, the less often they need to be dredged.The shorter they are, the more efficient they will become at transporting sand around them.

Sa, it's my belief that the decision was made a long time ago that these harbor entrances would stick out into the lakes sufficiently far to minimize the frequency at which dredging needs to occur.

O: And at the time they established that length which was according to my records or the records of the Corps 1903, no one had ever heard of depth of closure, had they?

A: They had not, and the effects on the downdrift beaches was also unknown at that dine and not known significantly until after WorldWar II when it became important to understand the processes that go on beaches in an effort to be able to land troops on beaches.

Q: So, there is no question that whatever harm has been done was unintentional as a result of these

A: The harm that has been done is the accumulated harm since 1903:That structure has done two things. It has blocked the shore parallel transport of material from north CO south and it has also deflected

A.008956

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some of that material offshore and, hence, being lost forever once its beyond the depth of closure.
Processes were known in the '60s and '70s that these effects occur and that there were mechanisms available to mitigate those effects, and it is also my understanding that it wasn't until the State of Michigan that forced the Corps of Engineers in the Section III studies to address the downdrift impacts of the federal structures.
Q: -Have you ever heard the figure 30 percent attributable under Section 111 to the Corps Structures?
A: Yes, I have.
Q: Could you explain what that figure means?
A: Section III studies attempted to identify the extent in percentage of erosion that occurred along the shoreline that was directly attributable to the federal structures.
'So, in arriving at their value of 30 percent, they considered the distance a particular property existed from the structure, what the background erosion rate this one foot per year might have been in the area and what other structures existed in and around the affected properties.
It's my understanding for most of

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the harbors they arrive at a value of about 30 percent for that portion of the erosion directly attributable to the structures, federal structures.
0: 'When you say they,you mean the Corps?
A: Yes,I do.
0: Have you ever done any work to verify that percentage?
A: Yes, we have.We've worked at three harbors in particular, St.joe,Ludington and New Buffalo.ln the case of LudingtOn when the Corps did the Section 111 study for Ludington they did a reasonable job in understanding the wave climate and the direction of sediment transport.
With Ludington being located approximately halfway up take Michigan, sediment transport goes both from south to mirth as well as from north to south depending on the waves, storm waves that are incident on a particular day whereas at St. Joseph in New-Buffalo there is almost always sediment transport in one direction from north to south.
Our work on the wave climate of the Great Lakes and the relationship of that wave-climate to varying water levels show the Corps did a good job when they did the Section 111 study for Ludington but

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the wave climate has since changed and what was the downdrift side of the structure is now the updrift side.
We presented that to Colonel Haid, the Detroit District Corps some three or four years ago —
O: Could you spell his name?
A: HA I D. He believed our analysis and they began to nourish the north side of Ludington rather than the south side.
We have done similar analyses at both St_joe and New Buffalo and find — and I don't recall the numbers offhand, but we do have ocean engineer lab reports like the one you've referenced here on the downdrift impacts of those two structures.
0: You don't recall what those percentages were?
A: I don't at present.
0: You could look thenf up for us?
A: I could and I could certainly provide you with the reports.
Q: I'd appreciate it_ I mentioned to you, and I'd like this to be on the record, in my phone mail that you are entitled to be reimbursed for whatever time you spend in this regard, and I plan to reimburse you.We can discuss that in more detail after the

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deposition is over.
At this point let the record show there has been no money paid to you at this point, is that correct?
A: That's correct, and I waive that right to be reimbursed. I'd like to just provide whatever data the laboratory has in its possession to both sides.
Q: Which raises another question.tdon't know if you've ever heard of Rule 706 in the federal courts, but there is a provision whereby you could become an expert for the court, and you *can't* become an expert for the court unless you are willing to be all expert for the court, and we've already discussed this with the judge, and right now I've no way of knowing•whether she's amenable or not, but I just present this to you
Have you ever heard of that option or that possibility?
A: No, sir.
Well, I'wouldn't expect — if you were offered that opportunity would you be willing to — now, that is not a voluntary thing in the sense of we would expect to pay you or the court I think it's shared, isn't it, with the parties and the court? I don't know. It's in there_

that "[t]he harbor jetties were originally constructed in 1903 and have been estimated to trap approximately 84,000 m3 of sediment per year." (PX-24 at 5) The 1997 Section 111 Report goes on to state that "Mlle bypassing analysis showed that the combination of the long jetties and the deep navigation channel acts as a total littoral barrier, trapping all sediment reaching this area from either the north or the south." (PX-24 at 79)

Second, both this Court and the Federal Circuit reviewed the Corp's 1974 Final Environmental Statement regarding Mitigation of Shore Damage Attributed to the Federal Navigational Structures at St. Joseph, Michigan (the "1974 Report"). *Banks II,* 314 F.3d at 1306-7 (quoting from the 1974 Report). Critically, the 1974 Report makes numerous references to the 1958 Report. (PX-22 at 43-45, 53, 148) The 1974 Report even provides a map detailing the proposed 1958 mitigation project as set forth in the 1958 Report:

> A survey report recommending shore protection and beach erosion control from the waters of Lake Michigan at St. Joseph, Michigan, and vicinity is described in House Document 336, 85th Congress, 2nd Session dated 17 February 1958. The project was authorized by the Flood Control Act of 1958 (P.L. 85-500)... Plate 6 shows the authorized project.

(PX-22 at 43-44; PX-132)

Moreover, this Court noted in its 2007 liability decision that the focus of the 1958 Report was not to assess erosion from the St. Joseph Harbor, *Banks v. United States,* 78 Fed. Cl. 603, 621 *(2007)("Banks III").* Nevertheless, according to *Banks IV,* the 1958 Report generally recognized (without specifying where in the study area erosion was occurring or to what extent erosion was occurring) that "erosion was attributable to the harbor structures and their maintenance." *Banks IV,* 78 Fed. Cl. at 621. Once again, however, this evidence was before both this Court in 2001 and the Federal Circuit in 2003 when the latter decided the statute of limitations issue. Therefore, the 1958 Report does not constitute new evidence at all, much less

evidence so different that there is substantial doubt as to the correctness of the Federal Circuit's decision.

Specifically, the Corp's 1997 Section 111 Report repeatedly makes reference to the fact the harbor jetties were causing erosion as early as 1945. (PX-24 at 3, 58, 69-70, 75, 79-80). The Corp's 1997 Section 111 Report states:

> Downcntting of the lake bed between 3 and 4 m has been reported by Foster et al. (1992) for the period between 1945 and 1991 south of the St. Joseph Harbor. The net alongshore sediment transport direction is from north to south. The harbor jetties act as a partial to full littoral transport barriers.

(PX-24 at 58) Consistent with this evidence, this Court found in *Banks 1* that Plaintiffs were on inquiry notice of their claims no later than 1989 because the Corp had been openly installing sheet piling and dredging the harbor channel since 1950, and shoreline erosion was noticeable. *Banks I,* 49 Fed. Cl. at 820. As such, both the 1958 Report and the evidence underlying *Banks I* and *Banks II* is the same — i.e, that the jetties were generally causing erosion south of St. Joseph Harbor and the Plaintiffs were aware of this general erosion.

In *Banks I,* this Court required that Plaintiffs "offer relevant, competent evidence to show that they filed suit within six years of the accrual of their claims." *Banks I,* 49 Fed. Cl. at 809, Although this Court held that the evidence fell short, the Federal Circuit reversed, holding that Plaintiffs' claims did not accrue until January 2000, specifically stating: "We are satisfied that the plaintiffs met their jurisdictional burden before the Court of Federal Claims..." *Banks II,* 314 F.3d at 1310. In making its determination, the Federal Circuit had before it the same well-developed factual record considered by this Court. *See Id,* at 1306-1308, 1310. That factual record contained substantial evidence that the St. Joseph harbor jetties were impermeable as of 1903 and that, consistent with the 1958 Report, Plaintiffs were generally aware that erosion was occurring in areas south of the jetties. As this evidence was before the Court of Appeals, the

new evidence exception (or any other exception) to the law of the case doctrine is wholly inapplicable. The Federal Circuit's decision that Plaintiffs' claims accrued as of January 2000 must stand and subject matter jurisdiction unquestionably exists in Court.[4]

B. Neither the Factual Finding that the Piers were Impermeable in 1903 Nor the 1958 Report Triggered the Accrual of Plaintiffs' Claims

Even if this Court finds that the law of the case doctrine is inapplicable, dismissal of Plaintiffs' claims is inappropriate. As set forth below, neither the factual finding that the St. Joseph harbor jetties were impermeable in 1903 nor the 1958 Report triggered the accrual of Plaintiffs' claims.

1. Standard for Accrual of Claims in a Gradual Physical Takings Case

When the United States takes private property through a continuing process of physical events, "a landowner may postpone suit until the consequences [of the governmental act in question] have so manifested themselves that a final account may be struck.'" *Banks I*, 49 Fed. Cl. at 810 *quoting United States v. Dickinson*, 331 U,S. 745, 749, 91 L.Ed. 1789, 67 S.Ct. 1382 (1947). Plaintiffs are under no obligation to file suit until both the nature and the extent of the taking is clear, i.e. when the "situation has stabilized." *Dickinson*, 331 U.S. at 749_ **In** *Boling v. United States*, 220 F.3d 1365, 1370-1 (Fed. Cir. 2000), the Federal Circuit stated that stabilization occurs when "it becomes clear that the gradual process set into motion by the government has effected a permanent taking" and when "the extent of the damage is reasonable forseeable." Furthermore, a gradual taking **claim does not accrue** whilst the landowner has "justifiable uncertainty" as to whether his or her loss is permanent and irreversible." *Banks II*, 314 F.3d at 1309-10. Still further, because of the unique nature of a gradual taking claim, the Supreme Court has directed courts to consider "principle[s] of fairness" rather than merely

4 Plaintiffs note that the impermeability of the jetties in 1903, as well as the 1958 Report, cannot be examined through a 2011 lens but must be viewed through the state of knowledge extant at the time.

relying on "a technical rule of procedure." *Forsgren v. United States,* 64 Fed. Cl. 456, 458 (2005).

In determining whether a gradual takings claim has accrued, courts apply an objective, rather than a subjective, standard. *Banks III*, 76 Fed. Cl. at 692-5. A landowner will be deemed to have acted as a reasonably diligent person in detecting a gradual physical taking. *Fallini v. United States,* 56 F.3d 1378, 1.380 (Fed. Cir. 1995).

More to the point, in order for a gradual takings claim to accrue, three criteria must be met: (1) a reasonably diligent plaintiff must have known that the government has effected a permanent taking; (2) there must have been no justifiable uncertainty as to whether the taking was permanent and irreversible; and (3) the extent of the plaintiff's damage must be reasonably forseeable. If any one of these three criteria is not met, a gradual taldngs claim will not yet have accrued. As set forth below, neither the factual finding that the jetties were impermeable *as* of 1903, nor the 1958 Report satisfies any of these criteria and, thus, the Federal Circuit's decision that Plaintiffs' claims accrued in 2000 must be followed.[5]

2. <u>A Reasonably Diligent Plaintiff Would Not Have Known that the Government Effected a Permanent Taking</u>

Neither the fact that the jetties were impermeable as of 1903 nor the 1958 Report would have put a reasonably diligent plaintiff on notice that the United States had effected a permanent taking of his or her land. As an initial matter, the taking of land through the blocking of the littoral drift is "an almost imperceptible physical process." *Applegate v. United States,* 25 F,3d 1579, 1582 (Fed. Cir. 1994). Because the effect of blocking the littoral drift is that the shoreline slowly recedes over a period of years, detection of the taking can be delayed. *Applegate,* 25 F.3d at 1582. Moreover, recognition that the St. Joseph harbor jetties were causing erosion to

5 Importantly, the mere blockage in 1903 is not a taking. The "taking" occurs when the land is taken above the ordinary high water mark after years of underwater downcutting and eventual bluff erosion.

Plaintiffs' properties prior to 2000 was complicated by erosion from natural causes; periodic fluctuations in the lake level; changes in wind direction; and the gradual spread of the harbor jetties erosional impact to south into the Plaintiffs' zone, all as referenced in the jurisdictional evidence below and the prior findings of this Court in 2001. Critically, under the rationale of *DickinsonlApplegatelBanks II,* plaintiffs must be aware, not only that they suffered a permanent loss by erosion, but that the permanent loss was caused by government conduct,

First, the fact that natural erosion occurs at Plaintiffs' properties has long been established. As this Court noted in *Banks .I,* historical data indicates "that the observed erosion of the St. Joseph's shoreline has been caused, in part, by natural processes," *Banks I,* 49 Fed. CL at 814. The Federal Circuit also noted that there was no dispute that some erosion of the Plaintiffs' shoreline occurs naturally. *Banks II,* 314 F.3d at 1306. As such, not only did Plaintiffs need to be objectively aware that erosion was occurring, they needed to be objectively aware that the erosion to their properties was occurring at a rate greater than the natural erosion rate.

Second, detection of erosion in excess of the natural erosion rate was made more difficult by the dynamic nature of the Plaintiffs' shoreline. Plaintiffs have acknowledged throughout the litigation that "apparent erosion" can occur due to changes in various factors such as wind direction and lake levels fluctuations. *Banks I,* 49 Fed. Cl. at 816. The Corps acknowledged these lake level fluctuations in its 1958 Report, indicating that "[s]hort period fluctuations up to about 1.8 feet, caused by winds and differences in barometric pressures, occur with annual frequency.' (PX-132 at 4) Consistent with this evidence, numerous plaintiffs testified at trial that their beach would "come and go" as lake levels changed and storms occurred. (Tr. 921:3-10; 954:15-16; 1299-9-11; 2321:22-2322;7) This apparent erosion can obscure the unnatural

erosion caused by the St. Joseph harbor jetties.

Third, the effect of the harbor jetties on the lakebed and adjoining shoreline to the south was a very gradual process that occurred over decades of time. This gradual process was not believed to have impacted the Plaintiffs' zone until_ the 1990s, As this Court acknowledged in the *Banks I,* witness testimony establishes that it was not until the Corps published its first Section 111 study [in 1973] that the downdrift impacts of the St, Joseph harbor jetties were even investigated. *Banks I,* 49 Fed. Cl, at 817; Defendants MQ11:loranclurn of Contentions of Fact. at. 1 (Pacer Doc. 191). Significantly, the Corp's 1997 Section 111 Report viewed erosion in Plaintiffs' area as "background erosion" (i.e. erosion from causes other than the harbor jetties) until shortly before the report was issued. (PX-24 at 58) Specifically, the 1997 Section 111 Report states that, until recently, the area just five miles south of the jetties "may not have: been significantly influenced by the harbor jetties." (1X-24 at 58) Similarly; witness accounts provide evidence that Plaintiffs enjoyed a significant beach during the 1950s and 1960s, (Ti. 995:8-22; 1748:11-18;12041-1205:24) This evidence demonstrates that, as late at 1997 (much less 1958 *or* 1903) the full impact of the harbor jetties wa.s fat from clear.

While the 1958 Report implies that erosion is occurring, in part, as a result of the St. Joseph harbor jetties, it makes no effort to quantify the impact the jetties are having on the erosion process or the zone of influence of 'the jetties.. Instead, the 1958 Report focused on preventative measures:

> The purpose of the investigation was to determine the best method for protecting the shoreline *against erosion by waves and current,* especially in the region immediately south of the St. Joseph Harbor *where severe erosion has occurred during the period of high lake levels,* and the extent of Federal participation in a comprehensive project.

(PX-132 at 3)(erriphasis added) Even if, for the sake of argument, the 1958 Report placed Plaintiffs on inquiry notice that the harbor jetties Caused some degree of erosion, they were

clearly not on notice that the jetties had caused erosion to their specific properties, much less a permanent loss. Simply put, Plaintiffs were not in a position in 1903 or 1958 to bring a takings claim.

Finally, even if government-caused erosion exists, that erosion must invade a landowner's rights before a taking can occur. Until the erosion takes land *above* a property owner's ordinary high water mark, there is no taking. *Owen v. United States,* 851 F.2d 1404, 1410 (1988); *Peterman v. State of Michigan Dept. of Natural Resources,* 446 Mich. 177, 199 (1994). As the Corp has admitted during discovery in this matter, the location of the ordinary high water mark varies from property to property and varies over time as it is affected by lake levels, storm events and other factors. (PX-61D) *See also,* Exhibit A, Corp's Answer to Interrogatory 18, Appx. to *Banks II* at 547. In fact, the Corp stated that, in order to determine the ordinary high water mark for Plaintiffs' properties, it would need to conduct a geographic survey. *Id.* Even then, the location would only be valid for the particular time the survey was conducted. *Id.* The 1958 Report makes no reference to whether the erosion that is occurring south of the jetties is above the ordinary high water mark of any property, much less the Plaintiffs' particular properties.[6]

The United States Supreme Court in *Dickinson* has set forth *a* public policy of fairness when evaluating the accrual of gradual takings cases. *Dickinson* 331 U.S. at 749. When the government leaves the taking to a gradual physical event and puts the onus on landowners to determine that exact moment when an ongoing process of acquisition becomes a permanent and irreversible taking, the strict application of accrual principles is not appropriate. *Dickinson* 331 U.S. at 749. Here, Plaintiffs were left to detect whether the St. Joseph harbor jetties were

[6] Plaintiffs note that even the Corp's 1997 Section 111 Report only refers to downcutting and not a taking above the ordinary high water mark.

nature of this ongoing construction of the jetties prevented Plaintiffs from ascertaining the extent of their damages, Until the structures were completed, Plaintiffs could not have known what their final impact on their property would be. Accordingly, under the reasoning of *Banks II,* Plaintiffs claims did not accrue until 2000.

C. Plaintiffs Did Not Have A Legally Recognized Cause of Action Until 1988

As a final matter, Plaintiffs claims could not have accrued, as a matter of law, prior to the issuance of the *Owen* decision, *Owen v. United States,* 851 F.2d 1404 (Fed.Cir. 1988) in 1988. Prior to *Owen* it was settled federal law that a property owner could not recover for a taking of its fast land absent a physical invasion. Because Plaintiffs had no cause of action prior to the issuance of the *Owens* decision and because Plaintiffs claims were, at a minimum, premature between 1970 and 1999 under the rationale of *Banks II, pre-Owens* should have no bearing to the statute of limitations inquiry.

Prior to *Owens,* federal cases uniformly held that erosion damage was not a taking where the damage from the federal project was caused, not by a rise in water levels, but as a consequence of some other interference with the natural water flow.[8] *See, Southern Pacific Company v. United States.,* 58 Ct.C1. 428 (U.S. Ct.C1. 1923)(government jetty caused ocean currents to change which eroded plaintiffs property; held, no taking); *Franklin v. United States,* 101 F.2d 459 (6th Cir.), *aff'd on other grds.,* 308 U.S, 459 (1939)(government dikes redirected flow of river and caused erosion to plaintiff's property; held, no taking); *Tennessee Gas Transmission Co. v. United States,* 173 Ct.C1. 1180 (U.S. Ct.C1.1965) (installation of government locks increased downdrift velocity of the river, eroding plaintiff's land; held, no taking because the locks did not raise the water level); *Pitman v. United States,* 198 Ct. Cl. 82 (1972)(barring

[8] Furthermore, Plaintiffs' property rights were not fully defined until the Michigan Supreme Court issued *Peterman v. State of Michigan Dept. of Natural Resources,* 446 Mich. 177 (1994).

claim for government-caused erosion outside a bed of a navigable stream); *Ballam v, United States,* 806 F.2d 1017 (Fed. Cir. 1986)(barring claim for government-caused erosion outside a bed of a navigable stream).

Needless to say, to argue that Plaintiffs takings claim was barred before they even had a recognized claim would be patently unfair. The settled law prior to *Owens* in 1988 was that Plaintiffs did not have a takings claim because (unlike the flooding in *Dickinson)* the jetties did not raise water levels, only blocked sand and altered lake currents. By the time the Federal Circuit in *Owen* overruled the prior law and held that there could be a taking claim for erosion damages, the government mitigation program at St. Joseph's was well under way. The 1973 and 1974 Section 111 reports suggested that it would take some time, but that continued placement of nourishment would fully compensate for the erosion damage done by the jetties-- meaning that there is no basis for this Court to hold that Plaintiffs' taking claim accrued before 2000.

This exact result was reached in *Applegate v. United States,* 25 F.3d 1579 (Fed.Cir. 1994). In *Applegate,* the erosional effects of the government jetties began to be felt in 1952, but the first suggestion that the government would attempt to mitigate the erosion (by building a sand transfer plant) was not announced until 1962. In other words, more than 6 years had passed, yet Applegate held that the mere promise of mitigation 10 years after the fact was sufficient to delay the accrual of the 6-year statute of limitations. Although the *Applegate* court did not explicitly explain why the promise of mitigation 4 years after the limitations period had otherwise lapsed was sufficient to preserve the plaintiffs' takings claim, the Applegate court did emphasize that *Owen* had overruled the prior law rejecting these types of erosion claims. *Applegate,* 25 F.3d at 1580-1. The clear implication of the court's opinion is that the clock on

CERTIFICATE OF SERVICE

I certify that I have filed a copy of the JOINT APPENDIX VOLUME I, II, III and IV with the United States Court of Appeals for the Federal Circuit via EFC on this 14th day of June, 2013.

/s/ Mark E. Christensen
MARK E. CHRISTENSEN